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REPORT OF PROCEEDINGS

OF THE

Seventh Annual Meeting

OF THE

American ✣ Water ✣ Works

ASSOCIATION,

HELD AT

Minneapolis, = Minnesota,

July 13, 14 and 15, 1887.

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J. M. DIVEN, - - - - Elmira, New York.
W. J. MILNER, - - - - Birmingham, Ala.
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JAS. P. DONAHUE, - - - Davenport, Iowa.
H. W. AYRES, - - - - - Hartford, Conn.

Secretary and Treasurer,

J. H. DECKER, - - - - - Hannibal, Mo.

Finance Committee,

A. N. DENMAN, - - - Des Moines, Iowa.
B. M. ESPY, - - - - - Wilkesbarre, Pa.
C. N. PRIDDY, - - - - - Leadville, Colo.

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PETER MILNE, JR., - - - New York, N. Y.
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J. G. BRIGGS, - - - - - Terre Haute, Ind.
J. T. FOSTER, - - - - - Chicago, Ills.

The Eighth Annual Meeting will be held at Cleveland, Ohio, April 17th, 1888.

INDEX.

PAGE.

Applications for Membership 6
Associate Members taking part in Proceedings 105
Election of Officers 104
Filtration or Subsidence 56
Financial Report 111
Ground Water as a Source of Supply 15
In Memoriam 110
List of Members 116
Natural Filtration 42
"Natural Filtration" reproduced 52
Organic Life and Matter in Water 65
Ownership of the Water Appropriated by Water Companies 94
Place of next Meeting 103
Private Water Companies 18
Private Water Companies vs. Public—discussion 38
Recording Pressure Gauges 24
Report of Secretary and Treasurer 14
Report of Executive Committee 13
Report of Committee on "Doherty Pipe Joint" 100
Report of Committee on Reprint of Proceedings 31-101
Revolution Counters - discussion 21
Should Storage Reservoirs be Open or Closed? 74
Taxation of Water Works—discussion 33
The Legal Relations Existing between Water Companies and Consumers 82
Unofficial Proceedings 108

SEVENTH ANNUAL MEETING

OF THE

AMERICAN WATER WORKS ASSOCIATION,

HELD AT MINNEAPOLIS, MINNESOTA, JULY 13, 14 AND 15, 1887.

MORNING SESSION, WEDNESDAY, JULY 13TH, 1887.

The members of the Association assembled promptly at 10 o'clock, in the Ladies' Ordinary of the West Hotel. The meeting was called to order by President B. F. Jones.

Upon calling the roll, the following gentlemen were found to be present:

ACTIVE.

Ayres, H. W.....Hartford, Conn.
Beach, G. E.....Minneapolis, Minn.
Bowen, Wm.....Oskaloosa, Iowa.
Briggs, J. G.....Terre Haute, Ind.
Brown, C. S.....Toledo, Ohio.
Buehner, Philip.....St. Paul, Minn.
Caulfield, John.....St. Paul, Minn.
Chandler, Geo. H.....Kalamazoo, Mich.
Decker, J. H.....Hannibal, Mo.
Denman, A. N.....DesMoines, Iowa.
Diven, J. M.....Elmira, N. Y.
Donahue, J. P.....Davenport, Iowa.
Espy, B. M.....Wilkesbarre, Pa.
Fanning, J. T.....Manchester, N. H.
Gardner, L. H.....New Orleans, La.
Gray, Carroll E.....Waukesha, Wis.
Hannah, Jos. E.....Winnipeg, Canada.
Harrison, H. H.....Stillwater, Minn.
Henion, J. W.....Minneapolis, Minn.
Holly, F. W.....Lockport, N. Y.
Hood, Chas.....Burlington, Iowa.
Jones, B. F.....Kansas City, Mo.

Kuhn, W. S.....Muncie, Ind.
Lyman, I. L.....Lincoln, Neb.
Mills, J. Albert.....St. Catherines, Ontario.
Milner, W. J.....Birmingham, Ala.
Molis, Wm.....Muscatine, Iowa.
Pearsons, G. W.....Kansas City, Mo.
Priddy, C. N.....Leadville, Colo.
Richards, W. G.....Atlanta, Ga.
Rinker, Andrew.....Minneapolis, Minn.
Ryle, Wm.....Paterson, N. J.
Stephens, B. F.....Flatbush, N. Y.
Troy, John W.....Pierre, Dak.
Walsh, Mat.....Minneapolis, Minn.
Wills, E. S.....Atchison, Kas.
Wirt, R. D.....Independence, Mo.

ASSOCIATE.

Bingham & Taylor.....Buffalo, N. Y.
Beaumont, R.....Kankakee, Ill.
Chapman Valve Co.....Indian Orchard, Mass.
Clow, J. B., & Sons.....Chicago, Ill.
Gaskell, H. F.....Lockport, N. Y.
Morgan, A. W.....Buffalo, N. Y.
National Meter Co.....New York, N. Y.
National Tube Works Co.....McKeesport, Pa.
Nelson, N. O., Mfg. Co.....St. Louis, Mo.
Newark Filtering Co.....New York, N. Y.
Union Water Meter Co.....Worcester, Mass.
Wood, R. D., & Co.....Philadelphia, Pa.
Worthington, H. R.....New York, N. Y.

NEW MEMBERS.

Applications for membership from the following were read by the Secretary:

Bergstrom, A.....Minneapolis, Minn.
Bixby, Walter A.....Galena, Ill.
Drummond, C. S.....Winnipeg, Can.
Getchell, W. H.....Faribault, Minn.
Jones, R. M.....Wyandotte, Kas.
Keeler, H. E.....Chicago, Ill.
Loweth, C. F.....St. Paul, Minn.
Moody, F. L.....Minneapolis, Minn.
Parrott, H. C.....Lockport, N. Y.
Pearsons, R. C.....Wyandotte, Kas.
VanCleve, H. S.....Pierre, Dak.
Weller, John.....East Saginaw, Mich.
Willard, W. H.....Eau Claire, Wis.

ASSOCIATE.

Galvin Brass & Iron Works.....Detroit, Mich.
Volker & Felthousen Mfg. Co.....Buffalo, N. Y.
Robertson, R. A., Jr.....Providence, R. I.
Columbus Water Co.....Columbus, Ohio.

On motion the Secretary was instructed to cast the ballot of the association for the gentlemen proposed, and upon their election being announced, were welcomed to membership.

ADDRESS OF THE PRESIDENT.

GENTLEMEN:—It now becomes my duty to call to order the seventh meeting of our association. I need not tell you the objects of it, but may urge prompt attendance at every session and ask you to display earnestness in the work before us. We are to discuss matters of importance to each one of us, to those we represent, and in fact, to the whole country.

We happen to live in a progressive and restless age; improvements in every department of life are proceeding at a ratio almost inconceivable to the human mind, and whether we can or not, we are expected to improve the water supply all over the country, to better satisfy the people and likewise improve upon the modes of supplying it, to satisfy stockholders and boards of public works.

When we consider the fact that sources of water supply once entirely pure and satisfactory, have become foul and unfit for use by reason of increase in population and consequent defilement, it is suggestive of a mighty problem in the future, which the members of the association, scientists, and chemists will be expected to solve. I am of opinion that persons representing private corporations in the supplying of water are devoting more attention and study to this matter than the cities are, and that the public are more inclined to question the quality of water furnished and the management, where the works are owned by corporations, than when owned and managed by cities. This is natural: those of us, therefore, who represent private corporations, should take advantage of every facility offered to improve our methods and keep pace with the exigencies of the times, for it is plain that if we do not, the cities will own all the water works in the country, which may or may not be the best for the whole people.

The known subjects for discussion at the meeting are:

Natural Filtration.....G. W. Pearsons.
Legal Relations. Consumers vs. Suppliers.....A. A. Godard.
Is Water Property?.....A. N. Denman.
Reservoirs, Open or Closed.....G. E. Beach.
Filtration or Subsidence.....J. D. Cook.
Local Distribution of Water.....P. Milne, Jr.
Fungus or Mossy Growth.....S. McElroy.
Elevator Indicators.....J. N. Tubbs.
Ground Water as a Source of Supply.....A. C. Sekell.
Water for Public Supplies.....Col. Wm. Ludlow.
Private Water Companies.....H. F. Dunham.
Revolution Counters.....Frank H. Pond.
Recording Gauges.....Chas. A. Hague.

The range is a wide one and others will doubtless swell the list. All will, no doubt, prove interesting and instructive.

A water works superintendent or manager, in order to be successful, must be able to master many difficulties; he must

intelligently consider all the elements entering into the matter of supply and distribution, of course he must rely greatly upon the Engineer, the Chemist and Scientist, if not combining all of them in himself.

For my part, the available men combining all the necessary qualifications are very few. Life is too short for the average manager of water works to pretend to know all that need be known concerning water supply in general and in detail, but he can do the best he can, and have the satisfaction of knowing that "Angels can do no more."

Our discussions are largely copied and commented upon in the public press and therefore should be dealt with intelligently and fairly. In this connection I desire to refer to a circumstance which should impress every one of us with the importance of accuracy and a perfect understanding of the topic about which he writes.

Our last meeting in Denver was one of the most delightful we ever had. The city authorities, the local water works officials and the citizens generally, treated us with marked consideration. It was reserved to the bad taste of the "Denver Tribune-Republican," *editorially*, on the morning of the 28th of June, 1886, *after adjournment*, to print an unfavorable and inconsiderate criticism upon an article read before the association, written by E. H. Keating, City Engineer, Halifax, Nova Scotia, upon the topic, "Fungus or Mossy Growth in Clear Water." The editorial at the time, was supposed to be from the facile pen of Mr. W. E. Hayward, but some of us are not disposed to credit so weak an effort to that editor, but rather to the fertile brain of some of the many drug store theorists or cranks who are permitted to infest almost every community. However this may have been, its effect to mortify and humiliate many of the association was complete. It reflected no credit to Denver, added no laurels to the fame of the gifted editor, and the only consolation to us lies in the fact that all the fools in the world do not belong to the American Water Works Association.

I know whereof I speak, when I assure you, although there is no patent on decency, that the press of this city was never guilty of such unwarrantable discourtesy.

The paper read was written by Mr. Keating upon a subject assigned by the committee. He stated his views as they had been learned from a very limited experience. They were practical, straightforward and business-like. It may be of interest to the complaisant author to have it reiterated that the growth spoken of does exist in the purest bodies of water of which we have any knowledge. In the great lakes, and St. Lawrence river, where the water is so clear that the bottom can be seen at depths of from ten to twenty feet, the same fungus is found plentifully. As to how well it adheres to surfaces, or whether it can stand the action of heavy currents, any one who has seen a screw propeller taken into dry dock can answer. Not only does it grow upon the hull, but upon the blades of the wheel itself, and the effort of the "Denver Tribune" was an exhibition of how an ignorant man can ventilate his private opinion in the columns of a friendly, but not over-scrupulous newspaper.

In conclusion, I beg to say that it is of importance to the well-being of the association that its members dwell together in

harmony. Some little unkind feeling, I fear, has been developed since our last meeting, growing out of some committee work. According to parliamentary usage, some member may feel called upon to "rise to a question of personal privilege." It may as well be understood now, that *this parliament* recognizes no such usage.

In our town we have an eccentric doctor (every town has one) who was consulted by an actress of rare beauty, requesting to be vaccinated at some place where the effects would not be seen. After considering the matter, and being pressed for an answer, Dr. Wood gravely said, "Madame, you will have to swallow it." My advice in this case would be the same, if you have a grievance, "swallow it."

We have present with us a guest, Mr. Y. Nakajima, graduate of the Imperial University of Tokio, Japan, engaged in the Department of Hydraulic Engineering, visiting this country and Europe for the study of the science as practiced here and there. Having spent the last six months on our work at Kansas City, I have taken the liberty of inviting him to join us here, and would be pleased to have him made an honorary member of our association. If any member will make such a motion I think we may dispense with formality.

On motion of Mr. G. W. Pearsons, Mr. Y. Nakajima, of the Imperial University of Tokio, Japan, was elected an honorary member of the Association. Mr. Nakajima responded:

MR. PRESIDENT AND GENTLEMEN:—I thank you very much for your favor of electing me as an honorary member of the Association. Though I am not at all entitled to such a high honor, I willingly accept it, because by being so, I shall be very much benefited in my study, by your wide experiences. I hope, however, that I will do something in future for the Association.

Alderman Mills in way of an apology for the absence of the Mayor, and in extending a welcome to the members of the Association in behalf of the City Council of the City of Minneapolis, spoke as follows:

MR. PRESIDENT AND GENTLEMEN OF THE ASSOCIATION:—We owe you an apology on account of the unavoidable absence of our Mayor, who it was understood was to perform the pleasant duty of tendering you a cordial welcome to our city. We expect him here in the course of an hour or two, and we hope you will bear with him and be kind enough to accept this as an apology.

As a representative of the Council of the City of Minneapolis, I take great pleasure in tendering to you a cordial welcome, and shall take pleasure in making every effort to make your stay a pleasant one. And after your labors are completed, and the objects and aims of your meeting accomplished to the entire satisfaction of each and every member of the Association, hope you will remain long enough in our midst to become acquainted with our people and investigate the industries and resources of our beautiful and prosperous city.

We assure you that we will use every effort to take care of you, and make your stay pleasant and we hope profitable.

I will now introduce to you Mr. Walsh, Superintendent of the Water Works of this city, who in the absence of the Mayor will formally receive you.

ADDRESS OF SUPERINTENDENT WALSH.

Mr. President, Gentlemen and Brother Members of the American Water Works Association:—I take great pleasure in joining my voice with that of Alderman Mills, who has just preceded me in extending to you a hearty welcome to the city of Minneapolis.

He has just assured you of a warm and hearty welcome to our city on the part of the City Council of the City of Minneapolis; and in behalf of the water department of this city I take great pleasure in extending to you a cordial welcome from each and every member of this department; and I assure you that each one will deem it a pleasure to do all in his power to interest and entertain you during your stay with us.

We are very proud of our city, and will take great pleasure and pride in showing you its advantages and calling your attention to the rapid and substantial progress we have made.

Those of you who have been here in former years need only to look around to discover and realize the progress we have made; and those of you who have never been here before will be perfectly willing to admit that ours is a prosperous and growing city. Those of you who have come here from larger and older cities, with their various departments fully developed, will not perhaps fully realize the wonderful progress and growth of this city.

Our growth has been almost unparalleled. I ask you, Mr. President and gentlemen, to look back a few years and note what we were then, then make the comparison with what we are to-day.

Forty years ago, where this beautiful city now stands, on the very spot where this grand structure, this monument of mechanical ingenuity and skill, in which we are assembled, stands, stood the wigwam of the Indian. At that time this great body of water, which constitutes our water power, was tumbling over our valleys, pursuing its course uninterrupted and finally mixing with the great waters of the gulf; but in time civilization and invention enabled the people to utilize these natural advantages and make at this place a water power second to none in this entire country, and which will be one of the means of building upon the banks of this river a city which will assist in the future development of the entire Northwest.

No doubt, gentlemen, in looking over our water department you will naturally draw the conclusion that we are yet in a crude state, but you must remember the fact that in the year 1866 the nucleus of our present system was laid, consisting of two small pumps, known as "The Holly," and with but a few blocks of wooden pipe. We have laid, up to this year, eighty miles of pipe, and we have now in process of construction over forty miles more.

We have a daily pumping capacity of nine millions of gallons, and are furnishing water for over eight thousand buildings and stores, producing an annual revenue of one hundred and thirty thousand dollars, and all this accomplished within the last twenty years. We have 1,032 fire hydrants, and 602 gates

in our water works at the present time. These figures may be tiresome, but I wish to present to you the contrast between twenty years ago and the present time, and call your attention to the rapid progress we have made in this line.

Now, Mr. President and gentlemen, while we are more than anxious to make your stay with us pleasant and agreeable as possible, you will pardon us for being selfish enough to manifest a desire to profit by your presence among us. We look upon you, gentlemen, as the embodiment of almost all that is practical in hydraulics and engineering skill of this age and country, and we desire you to devote a small portion of your time to a discussion and consideration of our system. We have none but the direct pressure system. The water is forced direct into and through the pipes, and you can realize, gentlemen, the great strain the pipes are subject to, and have to sustain in case of a large fire, when a large amount of water is suddenly forced through them. This is a question that I believe the officers of the department are most anxious that a small portion of your time be devoted to the discussion of, and any suggestions made to the Council by the association will be received and studied with great deliberation.

I now have one word more: I feel, Mr. President and gentlemen, that we would fail in a proper feeling of hospitality toward the members of the association, if I were to close without reminding you of the fact that at the special instance and request of the Water Board, the engineer has been notified to keep every thing in good running order so that there may be no lack of water during your stay in the city. With reference to its use as a beverage, I desire to extend a word of caution, and that is that it takes some time to become acclimated to our water; it takes a year sometimes, in fact we have some who have resided here for twenty-five and thirty years and have not yet become acclimated, and I fear they never will.

The arrival of Mayor Ames being made known, President Jones said:

We are very happy indeed to meet you, Mayor Ames. We have already listened to an address from Superintendent Walsh, which was very gratifying indeed, but assure you that we are very glad to see you here, and will be pleased to hear from you.

Mayor Ames responded as follows:

Mr. President and Gentlemen of the Convention:—I am sorry that there has been such a tremendous mistake, and that in consequence of the mistake I have not been able to meet you as I intended. I understand that there has been a carriage out hunting me, and at the same time I have been hunting for the convention. I have been all round the city hunting for your place of meeting, that I might meet you gentlemen at the time appointed. I was just on the point of giving up the search when a newsboy told me that you were meeting up here.

Now, gentlemen and friends, it gives me great pleasure as the executive of this thriving city of the northwest to bid you welcome to the city of Minneapolis and extend to you the hospi-

talities of its citizens; and I feel confident that these hospitalities will be bestowed in such a manner as to render your stay a pleasant one, and make such an impression on you that you will think of us kindly long after you have gone away.

We of the Northwest do not move as lively as the people of the South—we go slow but sure.

We propose while you are here to fish you, sun-burn you, dry you up and throw water on you.

We are, as you observe, gentlemen, considerable of a water town. With the broad Mississippi flowing through our city, and surrounded with numerous lakes, will enable us to furnish the drinking portion of the members with all the water they want. When you get through with your business, if water still has any charms for you, we would like to have you visit our pleasant lakes and take a drive on the boulevards that extend around the lakes, and would like to have you cast a line in them.

Now in conclusion, gentlemen, I will say that we propose while you are in our city, to extend to you the hospitalities that any good people would extend to another, and convince you that the hospitality of the people of the North is equal to that of the people of the South.

Now in behalf of the city of Minniapolis and its citizens, I extend to you a most cordial welcome, and hope you will have a pleasant time while you are in our midst.

Pres. Jones responded:

On behalf of the American Water Works Association, I thank you most sincerely for this kindly reception. We are delighted to see, many of us for the first time, your beautiful and prosperous city—the gateway to the great Northwest; your marvelous water power; your incomparable mills; your enterprising and watchful press, and all that marks the progressive city. We are somewhat disappointed in the temperature; it is not as cold as we expected; overcoats we find not wholly indispensable all the year round; and there does not appear to be much left of St. Paul's ice palace. If you had known we were coming, you would doubtless have kept it for us.

We are a very peaceable people, meeting once a year in conference to exchange views and experiences concerning one of the elements on which the health and happiness of the whole human family is absolutely dependent. All communities are not so fortunate as yours in this respect, and you are to be congratulated that many years may elapse before Minneapolis need feel any anxiety in the matter of pure water supply, unless we except perhaps, a dash of sawdust now and then, which is not unwholesome. Not so with New York, Boston, Philadelphia, Chicago, Cincinnati and other large cities.

We are here by invitation, and will endeavor to conduct ourselves as it becomes invited guests to do, and so far as it may be consistent with duty, we are at your service; but permit me to suggest that we have duties here, as well as privileges. To many present the discussions will be new; all are in search of information; all are not engineers or experts in any sense.

Among our number, however, you can find some amply able to select a source for water supply; some to tell you the proper kind of machinery to employ and where to get it; some

all about grate bars, smoke-stacks and perfect combustion, while many are supplied with chestnut bells for the advocate of smoke consumption. Others are experts in the matter of dealing with the public, making and enforcing, *agreeably*, rules and regulations; water rates, how to collect; water waste, how to prevent: water power, how to utilize; water meters, motors, elevators, indicators, and the like; and still others, doubtless, who could discuss more or less intelligently upon such subjects as fungus, algae, bacteria, microbes, organic matter, nitrates and nitrites, albuminoids and their special adaptability to the human stomach. So you can readily realize that, taken collectively and individually, there is wisdom in the camp somewhere.

Considering the fact that our forefathers as a rule lived to good old ages, we are inclined to think that it was fortunate that they were not aware, that practically all the fluids in the universe were filled with deadly enemies of mankind.

The Sanitary Era has published pictures of the microbes found in the Croton water, which are simply horrible to contemplate. We are told by scientists that one drop of water of fair quality contains, by actual count, *exactly 1200 microbes;* just think of it. Malarial fevers are said to be produced by air germs generated in the soil, and therefore the soil ought not to be disturbed. The mouth is a hiding place for microbes, therefore should be kept shut. They are even said to produce what is known as tartar or dental caries; the best remedy in this case is the tooth brush which, be it remembered, is an unknown luxury to many long-lived people.

I only mention these to give you a faint idea of the breadth and scope of our mission. We must not be content so long as science is piling these discoveries upon us. When we know that even so small an insect as a flea has been trained to work in harness, and a census taken of the microbe inhabitants of a single drop of water, there is uncertainty as to future possibilities in *science* and *patience*. So far the people seem to have the best of the struggle with the microbe tribe.

Speaking of fleas—

"The great big fleas have little fleas
Upon their backs to bite 'em,
The little fleas have lesser fleas,
And so on ad infinitum."

But I will not detain you with details.

The following report of the Executive Committee was read by the Secretary:

MINNEAPOLIS, MINN., July 13, 1887.

To the Members of the American Water Works Association:

GENTLEMEN:—Your Executive Committee would respectfully report:

That they have fixed the salary of the Secretary and Treasurer at $200 for the past year.

That they have examined the report and the books of the Secretary and Treasurer and find the same correct.

That they have had before them a paper presented by Mr. W. C. Conant, of New York, and that the same has been sub-

mitted to a committee consisting of Messrs. L. H. Gardner, A. N. Denman and James P. Donahue, who shall examine the same and report to the Association.

For the Committee,

B. F. JONES, PRES'T.

On motion the report was adopted. The Secretary and Treasurer presented the following annual report:

REPORT OF SECRETARY AND TREASURER.

To the Officers and Members of the American Water Works Association:

GENTLEMEN:—I have the honor to submit herewith my seventh annual report as Secretary and Treasurer of the Association.

Since the presentation of my last report the Association gained 42 Active and 9 Associate members; and has lost, by dropping from the rolls, 12; by resignation, 5, and by death, 1; R. G. Anderson, M. E., Scranton, Pa.

There are enrolled to-day, Active members 181; Associate 51. Total membership 232.

The receipts since my last report have been:

Balance on hand last report		$ 36 00
From Admission Fees	$300 00	
" Annual Dues	561 00	
" Sales of Proceedings	8 20	869 20
Total from all sources		$905 20

Disbursements:

Warrant No. 27, in favor of H. L. Denison, Stenographer		$ 90 00
" 28, " Standard P. Co., Pr'nt & Sta'ry		265 70
" 29, " " " Notices, &c...		35 00
" 30, " J. H. Decker, Office Ex.		84 50
" 31, " " " Salary		200 00
Balance Cash on hand		230 00
		$905 20

With hearty and sincere thanks to my fellow officers and members for the many courtesies received, this is

Respectfully submitted,

J. H. DECKER, SEC'Y.

Minneapolis, Minn., July 13th, 1887.

Approved: Executive Committee.

B. F. JONES, PRES'T.

On motion the report was adopted and ordered spread upon the minutes.

On motion of the Secretary, the courtesies of the Association were extended to the Engineers' Club of Minnesota, the Civil Engineers' Society of St. Paul, and the Faculty of the Minnesota State University.

Adjourned.

Afternoon Session, July 13th, 1887.

Promptly at 2:30 o'clock, Wednesday, July 13th, the members assembled and the meeting was called to order by the President.

Reading of a paper by Seeretary, from A. C. Sekell.

GROUND WATER AS A SOURCE OF SUPPLY.

BY A. C. SEKELL, GRAND RAPIDS, MICH.

Ground water is now a very common source of water supply, particularly in the smaller cities and villages. It is usually of good quality, and frequently it is vastly superior to any other water that is readily procurable. The question of the purity and wholesomeness of public water supplies is now beginning to receive more attention as the general public becomes better informed, and hence the study of ground water assumes increasing interest. What is ground water? It has been called the moving sea beneath our feet; a poetical but misleading phrase. I have heard it called "the second vein." I think a good definition, and one which would tend, if kept in mind, to prevent mistakes in judgment, would be this: Spring water that has not reached the surface. A spring is a fixed fact. Its flow can be measured with accuracy. It is subject to variations of season, of rainfall. Its yield is limited; its drainage area is a reality.

Now all true ground water supplies are subject to the same general laws that springs are. When ground water is pumped, as from a well or infiltration gallery, the flow of some stream, spring or collection of streams and springs is reduced by just this amount pumped. I think it is generally conceded that every spring has a definite drainage area, and if this is true, it is equally true that every well, gallery or basin which furnishes ground water only, has a definite drainage area.

The drainage area of a well located at the mouth of a creek may or may not coincide with the drainage area of the creek itself. The difference is this, the creek may drain the surface of the ground only, the well drains the ground itself of the waters that pass through the surface.

A study of any given source of ground water supply involves an examination of three subjects:

First.—That which relates to matters above the surface of the ground. The rainfall, its character as to the extent, number, frequency and distribution of the storms, as well as the annual quantity; the conditions of climate which determine the annual evaporation. These are so many and complex, that they need not now be considered.

Second—That which relates to the surface of the ground itself and its natural covering.

Its ability to absorb and retain water, or its tendency to permit free percolation. The nature of the vegetation, and the extent and character of the sloping surfaces, which determine largely the percentage of heavy rains that escapes into the streams as surface water. The sources of pollution which occur are also to be considered.

Third—That which relates to matters below the surface. This involves a study of the soil, the sub-soil, and the strata underlaying down to the line of permanent saturation. Upon the character of the sub-surface material, depends almost wholly the character of the water which will be furnished.

If information can be obtained upon these points when any given area is under examination, it may be possible to form an intelligent opinion upon these two questions. First—What will be the extent of the area from which the ground water will be drained, and Second—What will be the annual percolation within that area?

With these two questions answered it is a matter of calculation to determine the yield of the source in question. I am quite willing to admit that it is impossible in almost every case to answer either one of these questions with any certainty of accuracy, and yet I submit that it is much better to make the attempt than to go on blindly and risk the probabilities of failure. A ground water supply is like a bank account. The well or gallery from which the supply is drawn corresponds to the check book. The great quantities of water lying stored in the banks of sand and gravel which may extend for miles corresponds to the credit balance or cash on hand, while the occasional rain storm which furnishes enough water to produce percolation, corresponds to the occasional deposit. The simple fact regarding the failure of many ground water supplies is that the daily draft has been greater than the daily average of the percolation, a circumstance that should not be used as proof that ground water supplies are necessarily failures, or that they are liable to fail after a few years of operation.

In the selection of a source for ground water supply it is manifest that two essential conditions be secured; First—That the surface of the drainage ground should be as free as possible from sources of pollution, and, Second—That the drainage area should be ample in extent. The first of these essentials is too manifest to need comment. The second deserves careful attention. Let it be supposed that in regard to some given territory under examination that the annual rainfall is say 36 inches: that the disposition of the slopes is such that 12 inches of this escapes over the surface into the stream and is thus lost, and that of the remaining 24 inches, 16 are lost in evaporation and absorbed by the roots of vegetation, leaving 8 inches as the amount that sinks to the plane of permanent saturation, whence it moves slowly along to springs or open bodies of water. This 8 inches would amount to a daily average of about 300 gallons per acre, or 380,000 gallons daily per square mile. Under conditions like these, therefore, in order to be certain of a daily supply of 5,000,000 gallons of ground water, works should be so constructed as to command a drainage area of at least 13 square miles.

The amount of ground water that can be collected from wet or swampy surfaces is very small, as the annual evaporation from such places is liable to equal the annual rain fall. So too from heavy clay soils which are very retentive, as well as from steep slopes from which the rain water freely escapes. Probably level areas of sand or gravelly soils, nearly or quite devoid of vegetation, will give the best results.

I am well aware of the difficulty that surrounds any attempt to define the boundary within which the percolated

waters will reach any proposed works. Experience so far has been largely of the cut and dry character, and is likely to be so for some time to come. Wells are sunk 20 or 30 feet and pumping commenced; if, after a time, the supply seems to be insufficient, tubes are driven down some times several hundred feet, and some times into the underlying rock, or other expedients resorted to.

I think in many cases, however, it is possible, from an observation of the relative elevations of the wells and springs of a territory, to get a fair idea of the area which will be drained by any proposed works, particularly if the underlying rock formations are lying in level beds.

The best construction will be indicated by a knowledge of the general geological and topographical conditions which are found in any given locality, together with a knowledge of the quantity of water desired. If only a small quantity will answer, the ordinary well of 30 or 40 feet diameter may answer, if the location is favorable.

Often good results may be secured where the superficial deposits are of considerable depth, by sinking 6 or 8 inch tubes into the deep lying beds of gravel, the lower sections of the tubes being properly prepared for the admission of water.

Where the rock is too near the surface to admit of this, open wells sunk at a considerable distance apart, say 1000 or 2000 feet, and properly connected with a suitable conduit, will afford good results, or the same end may be reached with a low lying tunnel or gallery of pervious masonry, as at Columbus, Ohio.

The important thing is to so construct as to command the largest area of drainage possible, aad this is much better done with a tunnel or gallery of great length, than with a well of great diameter.

It is a mistake to suppose that if a well of 20 feet diameter yields a certain amount, that one of 40 feet diameter will yield four times as much: It is a mistake to suppose that if a gallery, tunnel or system of connected wells yields a certain amount, that a system draining four times the area will not yield four times as much water, if the conditions are similar in both cases.

The following letter was here read by the Secretary:

DISTRICT OF COLUMBIA,
WASHINGTON, June 25th, 1887.

J. H. Decker, Secretary American Water Works Association:

DEAR SIR:—I have your notifications of the meeting of the Water Works Association, on July 13th, 14th and 15th, and regret that it will be impossible for me to attend.

I have not been unmindful of the fact that I was to prepare, if possible, a paper on the subject of Public Water Supply, and have sought to discharge this duty, in order so far as might be to forward the purpose of the Association.

I am forced to abandon this intention, not only by reason of the great press of public business upon me, but because for the past month my time and attention have been entirely

diverted by reason of the serious illness of my mother, whose recent demise has not even yet left me any more time at my disposal than suffices to keep up the work of my office.

While my present sphere of duty has removed me from the immediate superintendence of water supply, it still constitutes one of the branches of the District Government of which I have direction, and the general subject itself is one which will always possess perhaps greater interest for me than any other.

I could, no doubt, furnish a paper, but in the absence of opportunity to give the subject due thought and consideration, I should feel that I would not be able to do either myself or the Association justice in submitting a hastily written communication.

I regret that such is the fact and that it will be impossible to meet the other gentlemen, but beg to assure you of my sincere interest in its welfare and advancement.

Very truly yours,
WILLIAM LUDLOW.

The Secretary then read a paper by H. F. Dunham, as follows:

PRIVATE WATER COMPANIES.

THEIR RELATION TO MUNICIPAL AUTHORITIES AND THE PUBLIC.—BY H. F. DUNHAM.

No one could attempt to prepare a paper upon a subject so important as the one assigned to me, without feeling a strong desire to know something about the work of those men who were the first to undertake the construction of water-works with private capital, and who doubtless, without suspecting it, introduced for their own success new opportunities for the exercise of judgment and skill in providing pure water for the public good. Not wholly out of place here would be a paper devoted to a description of the works established in 1581, by Peter Maurice, who rented the first pier of London bridge for five hundred years at ten shillings per annum, and the next season brought out the mayor and aldermen to see him throw water over St. Magnus' steeple, "the like of which had never been seen in all London before," and the like of which was not seen where promised in some of our own cities three hundred years afterwards. It would also be interesting to turn over the pages of some musty volumes, and make notes concerning "these plugs, which are no sooner opened than there are vast quantities of water." And "this plenty of water has been attended with another advantage; it has given rise to several companies to insure houses and goods from fire; another advantage which is not to be met with in any other nation on earth." A little careful study might make it clear that the private water company and the municipal authorities were the happy parents of our modest and thrifty fire insurance company, but there are those better fitted for such investigations, and I trust they may be pursued by some member at a future meeting, when it is to be hoped the necessity for reference to what is being done in our own land may not be as great as it is now.

A large and, I think, an increasing proportion of the members of this Association are the superintendents of private companies. Some are in charge of works that were well designed and carefully constructed, and others in charge of works about which fewer good words can be said. Any discussion of the causes that operated to produce in one instance a good plant, and in another a very poor one, will be of interest to you all, and of such causes or influences it could easily be shown that those first exerted are likely to be the most potent. To this class, including the early negotiations between private companies and the authorities of cities, this paper will be limited.

In order to be more easily understood, and because I like the inductive method, of which an excellent example was set for me last season by one of your members, I will beg your attention to conditions that are liable to be met with, merely assuring you that I have not the creative genius of Cervantes, and that I will not lead you to a pioneer city with a boom from which anything ridiculous might be expected.

You may call to mind a city of three or four thousand inhabitants, pleasantly located upon a terrace overlooking a river into which a small creek flows. Within a radius of a mile or two there are two or three beautiful lakes. Good water power and railway facilities are available, and the city and surrounding country are in a prosperous condition.

At a September council meeting a stranger appears who says the city is large enough to have water works, and mentions two or three towns where works have just been built. The mayor has for some time thought his city needed works; several members of the council have expressed the same opinion, and all see the force of one point made by the stranger. Up to that time water works had never been built in their city, and might never be built unless he (the stranger) built them at once. He would take water from the creek. It was, curiously enough, supplied from springs. He asks to have them appoint a committee to report at a special meeting, as his visit must be short. Here let me introduce the official record of the special meeting.

"Hon. A. B. C. submitted the report of the committee appointed to examine the creek and its sources. As to the purity of the water there was no doubt in the minds of the committee; as to its volume they would not commit themselves, but merely submit measurements of the springs in full, as follows:

Spring No. 1, 20 inches wide and 4 inches deep. Nos. 2 and 3 each 12 inches wide and 2 inches deep. No. 4, 24 wide and 6 deep. No. 5, 16 wide and 6 deep. No. 6, 24 wide and 4 deep, and No. 7, 14 inches wide and 2 inches deep."

You will observe that no reference to velocity is included, and doubtless it was not thought of by the committee. Had they given weir measurements, spring No. 4 was flowing one and a half million gallons per day. They simply cross-sectioned so much, more or less, stagnant water. But to go on with the record:

"Dr. D. E. F. addressed the council upon the purity of the water and suggested more time to consider the subject. A spirited discussion followed, which developed an overwhelming sentiment in favor of Blank creek and a speedy execution of a contract for the erection of water works."

The stranger departed with a franchise in which the city's interests were undesirably bound up for thirty years or more, and although he might succeed in disposing of it and securing through others the erection of works, the probabilities are that the company willing to pay the largest sum would build under it the poorest works and do the city the greatest harm.

But it may be urged that this is an instance of contract making without competition, and for that reason quite exceptional and not a fair illustration of actual conditions.

Let us turn over the record—imaginary, of course—of a larger city, population six thousand, where the subject of water works has been under consideration for several months, and propositions from water works companies have been solicited through the papers. The city lies upon a gentle slope in the center of a drainage area about one-third larger than the area of the city itself. The soil is a compact clay resting upon limestone, and the wash from the drainage area and the city streets form, in a wet season, a small brook which crosses the corporation line through some low ground. Near this brook an old resident has an inexhaustable well. We will also assume that there is no suitable source of supply within a radius of three miles.

For a week previous to the date of opening bids there hung in the council chamber a large map of the city showing by heavy lines the location of the proposed pipes, and bearing in one corner an inscription like this: "*Hydrants eighty. Total pipe, nine miles, only four or five miles of which need be of full size.*". It is further understood that the pumping station is to be built upon the low ground and within the city limits, otherwise it could not be taxed by the city.

When the bids are opened we need not be surprised to find that each competitor proposed to take water from the point designated by the city. Two of the bids received more attention than any of the others. They named substantially the same rentals and rates. One called for more elaborate and expensive machinery, and the other for a better pipe system and a large reservoir. Works constructed under bid No. 2 would cost about $20,000 more than works to comply with bid No. 1.

The representatives of the two companies, each with a few friends in the council, take in the situation at a glance. They have met before and may meet again in another city. One is not quite certain but he described a larger reservoir than the city needs. The other is very positive that the city needs no reservoir at all. They work together with a common purpose and as one man.

Just here let us imagine—as no such thing would be likely to occur—that one bid was for taking water from a reasonable source, three miles away, and for a reasonable rental. There would not be a possibility of the acceptance of such a bid. The chances are ten to one that the best bid offered would be rejected and that city, like the one already cited, would be burdened with a franchise in which it requires no engineering or other ability to read future mortality statistics.

I know that when errors are apparent in completed works it is natural to cry fraud and to throw the whole blame at some one's feet, but this paper will fail in its purpose if it does not help us to a wider and in one sense a more charitable view. The bad and the indifferent works established throughout the

country are but the natural results of influences, sentiments, business and unbusiness relations, which could only be changed very slowly, and they are not well enough understood now to enable anyone to foresee or limit the absurdities to which they may give rise.

So long as municipal authorities are profoundly ignorant or culpably indifferent, it may be expected that some one will be ready to secure a seeming advantage. To educate and interest such bodies, changed as they are by every political breeze, and by every other breeze, is equivalent to educating and interesting the whole community. Turning to private companies, there is more to encourage us. Their standard, although advanced by their own efforts chiefly, is being advanced. From an attempt to make the best possible trade, up to a determination to build only such works in any city, as that city ought to have built, is a long step forward, and one that was not, or will not be, quickly made.

In the meantime, which is now, any safeguards that will help to diminish the number of ill-assorted contracts ought to be recognized, and that heedless parent, the State, cannot be too severely criticised for neglecting to provide and furnish to every city within her borders such general directions about the character of the works required and the proper source of supply, as would go far to ward off the hasty agreement and its ruinous results. In the absence of such assistance organized individual labor would be of great service. Such careful work as that done by the Appalachian Club in topography and geology, would have no less to commend it if it bore a still closer relation to the health of communities. Just how much should be undertaken by scientific men, and men of leisure, by chemists, engineers and others, I do not attempt to say, and I urge nothing unprofessional, although I believe that no man's opportunities are lessened by the patient accumulation of facts and the intelligent use of them. We know that when water rises into the atmosphere it is watched by a hundred men, and very properly too, in its course from Puget's Sound to Eastport, if it goes so far, but after it falls to the ground it receives too little notice, unless its shadow darkens the page of some physician's journal. In the years before us this must be changed.

Mr. Pond having failed to present his paper entitled, "Revolution Counters," the subject was opened for informal discussion.

MR. GARDNER:—At the Denver meeting I made the statement that New Orleans was pumping fourteen million gallons per day, and I believed at the time that it was correct, but I have since ascertained that the pumping at New Orleans did not average over nine millions, or perhaps ten million, gallons, but the record showed fourteen millions. (Quoting from his Denver speech:)

"If the superintendent were owner of the works he would probably lock up the revolution counter and keep the record himself. This, or he would have a tried and

faithful custodian, such as he would trust with his life or with uncounted gold. Without going further in details, does it not seem that under some circumstances an engine record may be a document of very uncertain value, and quite questionable as a basis for any accurate calculations? I frankly say, that as excepting to the past eighteen months, I value my engine record for the past five years simply as a basis for fairly accurate guess work of the Captain Cuttle order. I wonder how many more water works officials could, if they would, confess to a similar experience?" I think I am a little better fixed now at New Orleans, as I have a trusty young engineer, and to him is given the key to the revolution counter.

I simply make these remarks to give you my views, and I would like to hear other members. I want to know what guarantee a superintendent has that the amount of water pumped is equal to or the same as that recorded by the revolution counter, or whether you employ a counter at all.

MR. PEARSONS:—Do you hold the engineer responsible for the fuel?

MR. GARDNER:—Yes, sir.

MR. BRIGGS:—I do not see what earthly object the engineer would have in fooling with the counter.

MR. PEARSONS:—My experience with revolution counters is that it is hard work to make a man take care of them. When mine wear out the engineer fixes them. I never had any doubt of his honesty about fuel, and do not think he got away with any; there may be engineers that would do a thing of that kind, but I do not think they are very plenty. I do not see that they would have any very great interest in meddling with the counter, it may be that some do, in that case it would be very well to keep your eyes open. There are a half a dozen ways of monkeying with the revolution counter; but I do not think from the experience I have had that the engineer would go back on the counter, there is more danger of the counter going back on him. We have ours repaired frequently. As a general thing engineers do not pay as much attention to their counters as they should.

MR. GARDNER:—To an engineer who is called upon frequently to supervise his fire and see that it is attended to regularly and properly, there is a temptation to do

something of this sort. Now the question is what is to be done in a case of this kind? If the counter has been tampered with you cannot rely upon it.

MR. HARRISON:—I wish to say that counters will lie, in this regard: if there is any slippage in your pumps there is nothing sure about the revolution counter. In some the slippage is enormous, in others it is very small. In that way I can see that the revolution counter will lie wonderfully. Sometimes the engineer will pick open the counter if he has no key. My engineer did that for me on one or two occasions, and when he did he got his walking papers. He can take his fingers and make several revolutions for one. Sometimes the engineer may be honest and the counter lie.

MR. BRIGGS:—I find that the average engineer gets entirely too lazy to do anything of that kind with his fingers. It is too much like work.

MR. BERGSTROM:—I find the counter all right, if it has not been tampered with, and has been kept in good order. If it is not kept in order, of course it is not reliable.

MR. CHANDLER:—For myself, I do not think counters lie. I do not think they will lie as quick as the pump will. If there is a leakage, that cuts no figure with the counter; the pump is to blame, or the man who has it in charge. The pump lies, but the counter does not.

The party who is in charge, of course, is to blame if it does not give a true count; but if he relies upon the counter and knows his pump is in good order, I do not see that anybody is to blame. They must have watching as well as anything else.

I have one that has been run for 16 years and it is in good running order to-day.

MR. PEARSONS:—Mr. President, this question of the slippage of water past the plungers is a very important one, and one this meeting ought to consider. There seems to be no paper upon it.

My experience with plungers is that there is a tendency to leak under very heavy pressure. Our plungers began to leak, and they soon got to leaking so fast as to be ruinous.

MR. BEACH:—I think this question of the slipping of plungers, or the slip of water past the plungers, is of sufficient importance to come up as a separate topic.

After passing through the regular order of business, I, for one, would like to see the question taken up. I think that would be proper. I would like to see a good talk on the subject, one that would afford some information.

The Secretary here read a paper, entitled

RECORDING PRESSURE GAUGES.

BY CHAS. A. HAGUE.

The element of force or pressure, in the development, transmission and utilization of power or energy in the various industries and demands of the world, is a very vital one, and the control and regulation therefore of pressure, to serve our purposes with the utmost economy and convenience, assumes an importance which can only be appreciated by observing the enormous loss resulting from the spasmodic fluctuations very often noticeable in steam pressures; not only as far as the *effects* of variable pressures are concerned, but equally in the direction of *waste* produced by the conditions necessary to cause the unsteady pressures. The main point in prosecuting any sort of enterprise is to know just what we are doing; as from that we can tell just what to do. In operating steam plants, especially steam plants for pumping water for public supply, economy in money is the factor to be looked to. Now by this it is not meant to be inferred that a narrow financial policy is to be advocated, but rather the idea that for any certain amount of total expense per annum, the greatest returns may be realized. A happy medium is the true line to follow, for it will be seen that a scarcity of appliances or inefficiency of management will cripple the works, while extravagant ideas in one direction will produce waste in others. Therefore, it must be an obvious proposition that to run a water works plant to the utmost usefulness, a good cool head must know all about what is going on. Of course this proposition extends out on various lines, but it is proposed to confine it in this paper to the consideration of pressures, both steam and water; the subject naturally dividing itself into these two parts.

A great deal of money that should appear upon the satisfactory side of the balance sheet, but does not, is absorbed by repairs and losses which need only be traced to their cause, to be prevented. Disputes as to how quickly a fire alarm was responded to, and as to how high the pressure rose, are of frequent occurrence. The attendants at a pumping station, who know that a good recording gauge is on guard in the office of the superintendent or chief engineer, out of their reach, are very certain to not only do their best, but also to take a pride in making a good record which cannot be disputed. It occurs to the writer that a comparison of such records at these meetings would be conductive of improvement, lead to enquiries as to why such a water works does so much better than such others, and would induce that diving into matters which is the only way that a knowledge really worth anything is acquired. The recording gauge holds within its potent grasp an entire encyclo-

pedia of information concerning fuel, grate bars, boilers, chimneys, dampers, steam pipes, engines, suction pipes, force mains, fire service, hydraulic elevators, firemen, engineers, superintendents, etc., etc.

First, with regard to recording gauges as applied to steam pressure; there are plenty of competent firemen, ready and willing to attend to their duties, but with whom it is an imperative condition that they be thoroughly acquainted with the demands made upon the boilers under their charge. Evidence in the shape of a continuous record of the results of a man's efforts, and the knowledge that this record is being produced completely outside of his power to manipulate it, can have just one effect out of two, either the fireman must give up his position or do what is required. And this is not a hardship, for steam boilers proportioned to their work are easily enough attended to by any fireman worthy of the name. The better the men, the more they want to know what they are doing, and they take a pride in doing their best when it is known and seen. Attention to duty and economy of fuel are co-incident factors as each secures the other. In spite of all so-called automatic devices for securing uniformity in the performance of steam machinery, a steady steam pressure in the boilers is more important than any single item involved. In a flouring or cotton mill, for example, an absolutely steady steam pressure would enhance the value of the automatic cut-off engine, enable it to control the varying load with greater exactness, and produce a closer uniformity in the product. Nearly all, if not quite all, demands on a steam boiler may be reduced down to a single proposition, viz: with a steady steam pressure, equal to the maximum wants, all demands are confined to the varying quantities of steam. Therefore, it follows, that to obtain economy in fuel, close attention to duty, the best performance of machinery, avoidance of explosions, damage and repairs, keep your steam pressure as nearly absolutely uniform as practicable. Wonders can be produced in this line by proper attention and a knowledge of what has been done, what is wanted, and what can be done. If your boilers are not adapted to their work, remedy the difficulty; but you *must* find out the trouble first.

If safety valves are supposed to be set at any certain pressure, you can never tell whether they have been tampered with, or whether they failed to blow off when that pressure was exceeded, or how many times a day or night your boilers have been exposed to an excess. There are more things happen to boilers at night, when they are supposed to be under low pressure, or when the pressure is supposed to gradually fall to zero, than people are aware of. If a careless fireman keeps up his fires too strong towards stopping time, when the machinery is brought to rest the heated bricks in the boiler setting walls will run up the steam pressure sometimes far above the regular working point; and if a blowing safety valve would betray such a state of things, the moving out of the weight will prevent the blowing, even if it does finally ruin the boiler. A good recording gauge will completely expose such practice, and not only that, it will sound an alarm at the precise moment the limit of pressure is reached. Doing a thing right may be acquired as a habit, and actually less labor is involved than in doing it wrong, but of course it is absolutely necessary

to know what is going on to shape one's course. If you know all about the pressure carried in the boilers at all times, and if your engineer and fireman know that this information is upon your desk, you may depend upon it that half the work of obtaining the best results is done, not from fear upon their part, but because they know you take an interest in what they are doing. If your boilers or machinery are not what they ought to be, the men are not to blame, but you will be put upon the high road of learning what the matter is. Leaks and consequent repairs of boilers and pipes are almost always caused by abuse, which is invariably denied in the absence of evidence to locate it. One of the hardest kind of hard facts in boiler explosions is that they are mostly caused by *over pressure*, and over pressure, whether sudden or gradual, is nearly always caused by careless habits in working boilers.

The engine is responsible only for the steam it receives, but the fireman is responsible for the amount of coal required in producing the steam; it has been demonstrated to be possible to get away with a third more coal than is necessary to produce the power required, simply by departing from the practice of correct firing. The fuel should be burned down to a proper point so that the furnace will not gradually fill up with unconsumed coal; the first thing a green fireman does is to gradually get his furnaces filled up with coal, working oftener and harder than necessary. If a number, say four or six doors, are to be fired into, each should be fired separately, with an interval between, regulating the damper to correspond, and keeping the water at the same level in the boilers. Fireing is much easier work when properly understood and manipulated. Some men will fill a furnance full of coal so as to have more time to walk around; up goes the steam pressure, because more heat is generated than is wanted, then the feed water is turned on and the water level is run up so as to keep the steam pressure down, the safety valves blow, or *they may not blow*. The dampers are closed, the fires smoulder, large quantitles of carbonic-oxide gas go up the chimney, which is simply an escape of unconsumed fuel not wanted at the moment; after a while the fires burn lower and down goes the steam pressure, helped down by a fresh furnace full of coal, the feed water is turned off and the water level run down to help the steam up. Imagine the final effects upon boilers used in such a manner, and also imagine how such an outrage can be perfectly exposed and prevented by a constant unerring record of what takes place every minute of the day and night. The position of fireman may be considered an humble one by some folks, but he is a man for all that, and his pride of what he can do is a stronger spur than anything else. Let him see that you care for what he is doing, and take a careful interest in his work; let him understand that his own grading depends upon himself as established by his record. You *must* pay him what he is worth, that is beyond your control and his; you may vary the wages, but you will also vary the firemen; you can squirm all you please but you can not get more than a dollar's worth for a dollar. The recording gauge is the arbitrator, you will both be brought to account by it.

The mistake under which many people labor, that they need no such record as a recording gauge will give, can be very quickly corrected by means of the charts which such an instru-

ment produces. The items alone of steam running up above normal pressure at night, and the inefficiency of safety valves implicitly trusted, would be found to be very numerous if looked into. When the chart shows a greater pressure than it has been determined to carry, something is wrong that can be remedied. When the chart shows considerable periods of steam pressure below an economical point, either the boiler or engine is not what it should be, or else the fireman is incompetent, in either event money is going to waste that can be saved by a knowledge of the facts, and we would have no suspicion even of the deficiency without the record.

The practical value of this steam record consists in its compelling the fireman to give close attention, and to exercise care and intelligence in firing, to maintain that uniformity of water level in the boilers, without which the best results can not be obtained. Although absolute uniformity of steam pressure can not be had, still the margin of fluctuation can be held within very close limits, as is attested every day.

The consideration of water pressure, as shown by the recording gauge, involves the performance of the pumping machinery, so that having briefly considered the economy and usefulness of steady steam pressure at the boilers, we will assume that we can have practically uniform steam pressure at the engine. Of all steam machinery, a pumping engine to do its best must have uniform steam pressure; and in every day work the economy in the use of steam, the ease with which it will meet varying demands and handle its load, must be seen to be fully realized.

Water works service in cities may be divided into two grand divisions; one in which the pressure in the mains is supposed to be constant, the other in which the pressure is held at a certain point for domestic supply, and the pressure increased in case of fire. In either case absolute uniformity of water pressure under any certain conditions aimed at is to be desired. In gravity works, of course, the item of friction in pipes as set forth by the relation between supply and demand, is the principal disturbing element; a recording gauge attached to the mains leading to any district will, in the course of a short time, show conclusively whether the pipes are large enough or not, or will locate any trouble in the shape of water hammer or in the matter of obstruction to flow, from whatever cause. Where pumping machinery is depended upon in part or entirely, it is not too strong to say that a recording gauge is well nigh indispensable for the best or even good results. A recording gauge chart shows the water pressure at any and all times during the hours it is on duty. Fluctuations in pressure to any amount and from any cause, are faithfully portrayed: any usual or unusual variations in pressure are detected at once. Any failure in fire service giving rise to disputes as to pressure, time, etc., etc., can be readily settled as far as the pressure is concerned by simply referring to this impartial monitor. The chart showing the precise moment the pressure was increased in response to the alarm, how long and how steadily it was maintained, and when it was reduced again to the domestic requirements. Fires sometimes occur on lines of pipe far from the pumping station, and although the record shows a prompt compliance with the alarm not to be disputed, the failure to get efficient fire streams

indicates clearly that either some obstruction intervenes, or else the pipes are not of sufficient capacity at the point required. Some times too many streams are attempted, instead of a few good ones, double the number of poor ones are used; a fire stream must be aggressive, and go in force just where it is wanted. The floors are the last places that burn in a building, and water just spilled in on the floors does not do much direct good, whereas a stream with dash to it and able to go searching up under the ceilings and among timbers, will be pretty apt to do some business. The application of a recording gauge at various points will soon determine the speediest and cheapest manner of remedying the difficulty. The presence of a water hammer, caused perhaps by a dead end or faulty circulation, will be indicated beyond mistake by the sharp and sudden raising of the tell-tale pencil. The sudden fluctuation of water pressure in pipes cannot be too carefully guarded against, as it means leakage of joints, waste of water, repairs and loss. The water wasted costs just as much to pump as the water used. The writer has in mind a water works system on the reservoir plan, under a pressure of about 120 pounds, where numerous house boilers commenced to give out that up to a certain day had seemed strong enough. After considerable damage had been done during two or three weeks, it was discovered that the trouble was caused by water ram, the result of a connection having been made for water for locomotives, and the valve closed very quickly when the engine tank was full. The application of an ordinary water pressure gauge graduated up to 300 pounds, developed the fact that the static head produced a pressure of 120 pounds at the point of draft; when the engine tank was being filled through a wide open 6-inch valve, the pressure fell to 85 pounds, and when the valve was quickly closed, as it always was, the pressure ran up to considerably above the 300 limit of the gauge, and after five or six vibrations from just below 100 up to more than 300, the pressure gradually settled down to 120 again. A smaller pipe, an air chamber and a safty valve cured the trouble, *after it was located.* A good recording gauge would have rung an alarm and disclosed the excessive pressure the first time it occurred, saving many times its cost. Innumerable instances might be cited, but they would only exhibit the surprisingly large number of unforeseen and unsuspected occurrences, possible in a system of pipes laid in the streets of a city for water works purposes. The ordinary gauge drops away and then comes back to the normal pressure, or raises and returns again to the regular point, but who sees it? It goes through the same fluctuations as the recording gauge, but who can read it? or realize what it means, until it is graphically delineated upon a chart divided off to suit the hours of the day. Even exhibiting when and for how long each sprinkling cart was drawing water; the precise moment that a pipe burst, and how long before the fractured pipe was shut off from the system; any irregularity in the operation of the machinery, etc., etc.

As to the various kinds of recording gauges before the the public, principal ones are the Edson, made by Jarvis B. Edson, New York; The Ashcroft, made by the Ashcroft Mfg. Co., New York; The Peerless, made by the American Steam Gauge Co., Boston.

The Edson instrument is what is known as a diaphragm gauge, while the Ashcroft and Peerless are constructed upon the Bourdon bent tube principle. The Bourdon instruments are actuated by tubes the same as a regular steam gauge; a small lead pencil being attached to an arm operated somewhat similar to the index of the gauge. The pencil traverses the paper ruled to represent hours, the line drawn by the pencil crossing the hour divisions at a distance from the starting point or zero, indicating the pressure; so that the distance of the line from zero at any point between or at the hour lines indicates the pressure at that time. In the Bourdon instruments the charts are moved by clock work through a period of twenty-four hours.

The Edson gauge is actuated by a corrugated diaphragm of tempered steel, which by a peculiar and ingenious mechanism, moves a pencil exactly vertical, and at the same time sweeps a regular gauge pointer or index through the arc of a circle graduated to show the pounds pressure per square inch. The spring arm carrying the pencil keeps the point at all times against the paper, while appropriate clock work moves the paper from left to right to correspond with the hours of the day or night during a period of twenty-four hours. One peculiarity of the Edson gauge, outside of its twenty-four hour record, is that the gross pressure upon its steel diaphragm on one hand, and the resistance of the diaphragm itself on the other, contributes to very great steadiness and certainty of motion, as the work thus done is so greatly in excess of any effort required to move the recording mechanism that the instrument is practically frictionless; the steadiness of its pencil line attesting the value of this feature, even at variations of the pressure to the slightest degree. It also has an alarm, operated by the clock, through the medium of an adjusting screw, set so as to ring a small gong in the instrument at any determined pressure desired.

In closing, it may be of interest in connection with this subject to note Mr. Edson's successful efforts to secure four test gauges, graduated up to 300 pounds per square inch. He constructed a mercury column of $\frac{1}{4}$ inch heavy hydraulic wrought iron pipe, at one of the piers of the Brooklyn bridge, then in course of construction in 1872. The column was carried up to an elevation of 265 feet above the point of observation, it being necessary to carry the pipe up on to the derrick then at the top of the pier, to get the desired elevation. The manner of dividing the column so as to define the different elevations of mercury exactly was peculiar, and consisted in laying off the pipe with a standard steel scale, and every ten feet a hole one-sixteenth of an inch in diameter was drilled and plugged. Days of the same temperature were selected for the experiments after the column was filled with pure mercury; the levels were obtained by withdrawing the plugs, beginning at the top of the column and letting the mercury escape down to each ten foot level successively. The indications were recorded upon four gauges made with plain, full Bourdon tubes, selected for the purpose, and with ten inch dials. This mercury column was the highest ever put up in this country, and probably in the world; the gauges being used only as master gauges, are probably as good to-day as when made.

There are matters pertaining to the uses to which recording gauge charts may be put, in connection with steam boilers,

the regulation of the fires, and economy of fuel in the fire room, which, although not exactly foreign to the subject, would extend this paper beyond a judicious limit. The opportunity may arise for a further extension of the questions involved at some future time.

MR. PEARSONS:—About recording pressure gauges, when one has used them they will find them very necessary and very essential. Before they were in use in our town we had a good deal of trouble, every once in a while complaint would be made that at a certain hydrant they had no water at such and such an hour of the day. The consumer, who was perhaps inclined to be unfriendly, would say that it was lack of pressure at such and such a time. Now the recording gauge settles that, and they can not come it over you in that way now. You can feel secure in your slumbers, even while you are in bed asleep they are doing their work. This is my experience with recording pressure gauges.

I have known a good many engineers and firemen to be caught up with, for neglect of duty, where this record was in use: they could not say that they were not negligent or were not asleep, for there was the record against them. It records the engineer and fireman on duty, quite a valuable record for us at times. It records the height of water in every section, and the supply, which forms a very important feature. We can tell during a fire exactly when a fire breaks out, exactly when we get the information, and how much water has been used during the fire. This is very important. You can tell the location of the fire and the pressure maintained there, and the fireman can not say that he did not have the pressure.

MR. DENMAN:—There is a question I would like to ask. I would like to know where two boilers use the same recording gauge, if the fireman should neglect his duty and allow the fire to go down in one, and keep it up in the other, whether the recording gauge would record the highest pressure?

We had a fireman who had been in our service a good many years and whom we valued very highly. One day the general engineer was passing through the boiler room and he found the fireman in great alarm, and on examination found the boiler in common use wanted filling, but saw it in time to correct it. Our recording gauge did not say that there was anything the matter with the boiler. I suppose we narrowly escaped a genuine old fashioned blow-up.

Another thing about the recording gauge, if the engineer should fall asleep, it would peach; he knows this,

and he tells the fireman: "John, you take a little snooze and I will watch," and on the other hand the fireman says to the engineer, "You take a little snooze and I will take care of the engine." The recording gauge keeps at least one man on duty. I was going to say these recording gauges need the same watching that steam gauges do.

Col. Henion here announced the following programme of entertainment:

The members of the Association are invited to a visit to Minnehaha Falls. They are requested to be on time to take the 4:50 motor train, to-morrow afternoon. The time of returning will be seven o'clock.

You are invited by the Engineer's Club and the Water Board of St. Paul, to visit their city on Friday afternoon. They are making the necessary arrangements and the program will be announced to-morrow during the morning session.

On Saturday, at 9 o'clock A. M., carriages will be in waiting at the hotel to take the members of the Association for a drive about the city, to the mills, St. Anthony Falls and the pumping station; after which, in the afternoon, you will be requested to go to the Union Depot on Hennepin avenue and First street, at 2:20, and take the Manitoba train for Lake Minnetonka, and there take a steamer for a tour of the lower lakes. A banquet will be prepared at the Lafayette hotel, the train leaving for Minneapolis at 10:40 P. M.

Evening Session, Wednesday, July 13th, 1887.

Meeting called to order at 8 o'clock, by Vice President Milner.

REPORTS OF COMMITTEES.

Mr. Beach presented the report of the Committee on Revising and Reprinting Proceedings of 1881 to 1886, inclusive.

The resolution authorizing the publication seemed to admit of various constructions, or being too indefinite; some of the officers taking the view that no appropriation had been made, and further, that the association had no constitutional authority to levy a special assessment upon the members without their consent. This course left your committee without any funds whatever with which to get the work out, except such as

could be raised by voluntary subscription and from advertising, to which your committee turned their attention. From a personal correspondence with all the members, we found such a general desire to have the work published, and a sufficient support from subscriptions and advertisements to insure a large portion of the cost, that in February last the committee decided to proceed with the work and carry any balance required until the meeting of the Association in 1887. Your committee contracted for the publication and electrotyping of 500 copies to be finished in May, but various delays have kept the work back until the present time. We find great difficulty in obtaining original matter, especially the various plates and the report of the third annual convention, as from an appeal to every member we find only three copies of the third report in existence. The plates having been mostly destroyed by fire, it was impossible to procure new ones in time for this session, so the work was proceeded with without the plates. We hope to procure new plates and present them to all subscribers, so that they may hereafter be placed in their proper place in the book. The entire cost of the work has at present amounted to, in round numbers, nearly $1,200; amounts pledged from advertising and subscriptions, between $800 and $900, leaving something over $300 unprovided for, but with something over 200 copies of the work on hand for sale. Amounts subscribed were at $1.00 per copy, but from the fact that at that price it would not pay the expense of getting the work out, the committee have put the price of such as were not subscribed for at $1.50 per copy, which, if all copies are sold, will a little more than pay the total expenses.

We hope, before the close of the convention, to present an itemized statement of receipts, disbursements and assets, which we are not at present able to do, but will say in conclusion that no bills whatever have been incurred in the name of the association, the committee assuming the entire expense.

Hoping the work will prove satisfactory, we remain, etc.,

G. E. BEACH, Chairman.
I. L. LYMAN.

Mr. Beach:—I would like to have the convention take action upon the question as to whether it would be proper to charge anything in excess of the subscription price of $1.00 per copy?

We do not wish to saddle anything on to the Association, but as the committee have assumed the expense, if we limit the amount to $1.00, it will leave the committee considerably in the lurch, unless we can dispose of the entire number of copies now on hand.

Those who have subscribed at one dollar I suppose should have them at that price.

Mr. Pearsons:—I do not recollect whether I subscribed for ten copies or not, but I want them anyway, and if I am not one of the lucky ones I will pay $15.00 without kicking at all.

THE PRESIDENT:—The first question to decide is what we will do with the report of the committee.

THE SECRETARY:—I move that the report be referred to a committee of three, consisting of the members of the Finance Committee who are present, and one member to be added by the Chair, and that said committee report Friday morning. Motion carried.

The Chair named L. H. Gardner to act with the Finance Committee.

THE PRESIDENT:—The next thing in order is opening the Question Box.

The Secretary read the following question: On what basis should water works property of private corporations be assessed and taxed, compared with other property in the same locality?

THE PRESIDENT:—We would like to hear from some one on this question.

MR. BEACH:—This is a matter I am very much interested in. I have, during the past year, corresponded with the officers of a great many water works companies, to get at the basis on which they were assessed and the amount of taxes paid. One man said, just go ahead and do the best we could, for it was a matter that had not been adjudicated by any court, I have not been able to find a case that has been passed on by the courts.

I am president of a water company and considerably interested as a stockholder. We have the reservoir system with a capacity of a million gallons, and forty-five hydrants. We are exempt from city taxes. The state listed our property at $10,000, for pipe, buildings and hydrants. The matter went to the county commissioners and the state board of equalization, and they simply multiplied it by five and made it $50,000, placing the real-estate alone at $10.000, that representing one-third the value. We went to the district court and argued the case by attorney, claiming that the county commissioners and board of equalization had no right to assess or change the valuation. It was thrown out of court. The case was simply one of spite against the water company.

The case went to the supreme court and was referred back to the district court for a re-hearing. It was finally compromised for one year's taxes, the county being willing to compromise and fix the assessment at $10.000.

With the exception of a few with whom I had corresponded, and I had received answers from nearly all, the idea seemed to be that we had no reason to complain; taking the ground that water works were looked upon as a public benefit and in consequence were taxed nominally, and in a great many cases were not taxed at all or comparatively nothing.

My views of the basis of taxation gathered from the history of water works companies, and from a careful examination of the question from legal authorities is this: Water works property, including mains and hydrants, should be taxed upon the basis of what that particular part is worth, not what it is worth in connection with the water works, nor what it cost. It is unjust to tax us upon the cost, for that does not represent its present value, but what it will bring in the market, not what it would sell for by selling the entire water works; but what a block of that pipe if taken up and sold for taxes would bring. It should not be taxed as real estate, adding to it the value of the skilled labor required to put the pipes in the ground, upon the theory that it enhances the value and that we ought to pay taxes on the increased valuation. We ought to be taxed on the basis of what it is worth for use, less the cost of taking it up. If you have a franchise it can not be sold for taxes, therefore water works should not be taxed on the same basis as other property. If you build a house upon a piece of land you know that land is improved to the amount of the labor and material put upon it; on the other hand laying the pipes in the street gives you no interest in the real estate, nor does it enhance the value of the pipes in the least.

I sought to draw out this discussion to ascertain the basis upon which water works throughout the country are taxed. It is my impression that this question will have to go to the courts, and I presume the highest court in the land, before it is adjudicated. If any of the members here have any information as to the courts having acted upon this question, I would like to hear from them.

MR. DONAHUE:—It seems to me that there must be some legal means of settling this question, but I think the matter of taxes is something that ought to be adjusted when the franchise is obtained. We are exempt from taxes.

MR. WIRT:—In regard to doubling the valuation, we had a little scrape of that kind in our town. We returned to the assessor the valuation of the pipe, machinery and

the ground they were located on, and he doubled the amount on us. We went before the city council and argued the case; I then happened to have, I think, a decision of the Supreme Court of New York. The decision there was that water works company ground was not personal property. In showing this to the council I convinced them that they had no right to assess at all, much less double the amount.

MR. HENION:—It seems to me that we ought not to influence the courts by our arguments here. This matter seems to be a question for the courts to decide instead of the water companies. You must, of course, get the franchise for the water works, and as Mr. Donahue says, it is better if possible, to settle this question then.

THE PRESIDENT:—It seems to me that all we can do in the discussion of this question is to get the individual knowledge of the members of the Association. It is not likely that anything we might say would influence the courts. We may have some knowledge, and if we have let us give it to those who may need it. We might consult some of the scientific journals of the country: I presume the Engineering News would have some valuable knowledge on the subject.

MR. STEPHENS:—I am interested in three water works. I might say one is not taxed at all, one nominally and the other considerably. I think it is our duty to look after a brother who has fallen into trouble and help him out, by doing the best we can to get a rebate or lower his assessment.

I think this a very important question. If the pipes under the ground are to be taxed we ought to know it.

THE PRESIDENT:—I think it just and proper that we should impart all the information we have on the subject.

MR. BEACH:—It is all right to have the arguments and statements of the different members in regard to the manner in which they are taxed, but in time the question will have to be decided by the legislature; and we, perhaps, until then, will have to be satisfied with what is customary over the country; but I know it is not the custom of the country to tax water works three or four times what they cost.

MR. GRAY:—My observation and experience on this question leads me to the opinion that it is becoming on the whole a more important question than formerly.

Municipal authorities and officials are becoming of the opinion that water works property is a pretty good thing; and I think the water works men are responsible for the opinion throughout the country. Times are pretty good and they are stocking up heavily, and they do not keep their secrets; they make this known.

The municipal authorities become somewhat dissatisfied and think perhaps that they could have done better, and that the contract made with this company is something of a burden, and their means of retaliation is to tax them heavily.

Some companies I have been interested in have met with this same experience. I think there is a disposition to reach out and tax them all they will stand. The opinion I have formed from inquiries I have made is, that we must stand the same as other property owners, we must stand the same assessment, the same valuation and the same taxation as other property stands. The trouble is that we have no relief unless we go to law. I am not aware that the question has ever been carried to the higher courts. It is not confined to water works companies, but extends also to gas companies.

It is a question we have all to meet and battle with more or less, and is a very important one; what the result will be I do not know. All that we can do is to compare views and govern ourselves accordingly in the future. It is my habit and custom to prevail upon the assessors to compare our property with other similar property, consequently we have never had any serious difficulty in that way.

Mr. Millard:—They assessed us last year for the first time. They found out how much the pipe cost us and assessed it against the company as personal property, and assessed all other property as real-estate, making our taxes pretty heavy. This year we got a reduction by getting them to allow us to take a $25,000 assessment.

Mr. Gray:—I meant to state when I was on the floor of some cases, two or three, that I call to mind, where there had been quite a controversy held over the question as to whether the mains should be taxed as real-estate or personal property, or whether it should be taxed at all, but no two could agree.

Another question has been remarked upon by one gentleman, that is, that this matter of tax ought to be looked after at the time the franchise is obtained. I know it is a very common thing with most of us to arrange for

the works to be free for a term of years, but I think some have come to the conclusion that this is not legal; in our State it can not be done. I do not think there are many works that are trying to get altogether free of tax.

MR. BRIGGS:—Indiana taxes them on the capital stock, and we set that as low as we can.

THE PRESIDENT:—We have a franchise in Kansas City and are exempt from taxation during the term of the franchise. While it may not be legal for the people to make that kind of a contract the effect is the same. We do not interest ourselves at all about the assessment.

It is not so with our plant in Wyandotte. We have to pay taxes there and the question comes up every year. They wanted to tax it as personal property, I did not think it should be so taxed, but thought it should be taxed as real estate. We do as one gentleman here has suggested, that is—the best we can. I think we ought not pay anything.

MR. HENION:—As I understand this matter, a corporation is not asked or expected to build water works unless they think they are going to pay, at least I never heard of it before. If a man goes into this business and does not take care of the taxes, I do not see who is to blame but himself. If he was unable to strike down the valuation, and his business was increasing very rapidly, he might have a very good thing even at that.

I do not see how the Association can decide this question at all. Of course we can hear the members and their experience with assessors, about doubling valuations and all these things, but I do not see how it will decide the matter.

MR. BRIGGS:—There is a little matter of duty I desire to bring before the Association.

All of the members of this Association, who were present at the convention at Columbus, four years ago, and many others who have received his excellent reports, remember Frank Doherty, the superintendent of the water works in that city. And here let me pay a passing tribute to his memory: As a man—personally liked by all who knew him. An efficient, intelligent, progressive water works manager. By his death the Association lost one of its most valuable members. I am satisfied our Secretary and others who visited him then, will bear me out in my statement. He was devoted to the profession and originated quite a number of new ideas. His long gallery

for getting a supply of water was, I think, the first of any extent in the country. He was never satisfied with the present style of joint for cast iron pipe. He argued that to yarn a joint well took time, that the yarn would get rotten, that where the bead end of a pipe was off that the yarn would work out into the pipes, etc. After studying the matter over and making experiments, he patented a joint in which a soft iron wire took the place of hemp. He had great confidence in its efficiency. In fact he found, by experimenting, that it was tight under 125 pounds pressure. After his death Mrs. Doherty sent copies of the patent to Mr. Decker and myself, with the request that we would lay the matter before the convention at Cincinnati. It was near the close of the session, and I don't think it received the consideration it should have had. The Secretary coincided with me in that opinion, and I have taken the liberty of bringing the subject up again. I think rather favorably of it myself, from the result of some experiments I have made, and I would here remark that if you are much troubled with water when making a joint, take a piece of wire, wrap it with cotton cloth, and if you can keep the water in the pit down until you can drive the gasket in you are all right. It seems a little strange that with as much attention as has been given to cast iron pipe lately, as many articles as have been written on it, any improvement on the old-fashioned way of making a joint has never to my knowledge been alluded to. I have a full-sized drawing of a 6-inch pipe, and gentlemen, will you examine and pass judgment on it. It looks to me like a good thing. Whether practical use would show up its defects I cannot say, but I think at least one pipe factory thinks well of it, and would be glad to have its merits discussed.

THE SECRETARY:—I move that the matter be referred to a committee of three who shall report upon its merits, during the present meeting. Motion carried, and the chair appointed Messrs. Pearsons, Stephens and Richards.

QUESTION:—Which gives the best satisfaction, water works owned by private corporations or those owned by the city?

MR. WELLER:—I will state, Mr. President, in connection with that, that the works that I represent are owned by the city, but there is talk now of selling them to a syndicate. We have a population of about 33

thousand. We have about 40 miles of pipe and the revenue is something over $26,000 annually. They are run at an expense of about $13,000.

THE PRESIDENT:—What did the works cost?

MR. WELLER:—That is hardly a fair question, as they were built at a very expensive time.

THE PRESIDENT:—What are they worth now?

MR. WELLER:—Probably $350,000.

THE PRESIDENT:—Can they be built for that?

MR. WELLER:—I think so. Our pipe cost $100.00 per ton loaded. I would like to hear some discussion on this subject.

MR. GARDNER:—Over one-half of the water works of the country are owned by private companies. I think statistics will show that the water supply has been much more satisfactory than where they are owned by the city.

MR. BRIGGS:—I think on the average it is a great deal better to have them owned by private companies; it costs the people less than if they are owned by the city, though there are exceptions. One great trouble with city management is, when there is a change of officers, nobody knows what is to be done with the water works.

THE PRESIDENT:—I am inclined to think it would be a pretty good plan, Mr. Weller, for your city to sell out to a private corporation.

You state your net income to be $13,000, five per cent is a very reasonable interest, that would be $17,500, on your own valuation.

I do not see how a private corporation could make any money unless they could do better than the city.

It may be more popular for the public to own the works than to have them owned by a private corporation —some people do not like corporations very much. It may seem to be cheaper to the citizens for the city to own and operate the works, but indirectly they have to pay more. Those are my views of the question.

MR. CHANDLER:—Where the city own the water works they try to build up the city in which they live, at least I know it is the case with us. We take a liberal part in anything that tends to increase the population of our city. The first question that arises when a private cor-

poration invests in water works property, is, what have they bought it for? Certainly they bought it to make money out of it.

We have probably fifteen miles of pipe that does not pay two per cent. on the investment. These pipes are put there for fire protection and to enable us to have public watering troughs, or anything of that kind. We have made a good deal of outlay by the way of public policy in inducing manufacturers to come there. A great many private companies would not have been so liberal as to do this.

THE PRESIDENT:—I am inclined to think that the city ought not to own the water works, any more than they ought to own the bar-rooms or grocery stores. I know that in Sedalia they built water works at an expense of $125,000, and got in debt to the full extent of the law, and notwithstanding the amount invested, they had very poor water and very poor service. They have recently sold the water works to a party in St. Louis for $100,000. Property they say cost $125,000, and I think it cost more than that. I offered them $40,000 for their plant, but the St. Louis parties offered them $100,000, and they accepted their offer.

MR. GRAY:—In the town the Chairman speaks of, I was called in as an adviser when they were discussing the propriety of selling. The history of the works is about this: Some thirteen years ago they built the works at a cost of $150,000. They were built on the Holly plan. They made a bad selection of an engineer, and the works were not well looked after; the water supply was never sufficient, their pumps were troublesome, and the rust destroyed their machinery.

It was the prevailing opinion that the works had been destroyed by political mismanagement. I think I can call to mind several works of that kind.

Then again, as far as my observation goes, there is a disposition on the part of the city to extend certain privileges to certain districts to please certain men; the question never arises in their minds whether the extension will pay or not. Then arises the idea that in order to get in manufactories sacrifices must be made, and they are made often time regardless of losses. It is generally on account of this sort of mismanagement that they fail to pay. In a good many instances, however, they are handled as well as they can be, and are managed on strictly business principles.

MR. CHANDLER:—I think a city can build and manage water works just as cheap as a private corporation. In the place where I live we established water works in the year 1869, which are not controlled by politics in any sense of the word. At the time the city established the water works they started by putting $25,000 into works which to date have cost $365,000; and now they have no bonds, pay no interest and have a revenue of $14,000, outside of the supply for the city and our large park. I think this idea of private corporations owning the works being cheaper to the citizens than the city owning them is all bosh.

I have been there seventeen years and know something about it.

MR. BRIGGS:—How many times have your politics changed?

MR CHANDLER:—They change every year. We vote prohibition and everything else, but it does not interfere with the water works system. Politics have nothing to do with our water works; neither party can say that they own or control them.

MR. WELLER:—I do not think it is cheaper for the tax payers to have a private corporation own the water works, than it is to own them themselves.

We get about $26,000 revenue for water. Now, I have made some inquiry of gentlemen who own water works, and from the best information I can get, the money is made principally from public consumers, and if these gentlemen owned our water works they would tax our city about $50,000 for water. Now add $50,000 to $26,000, and they would have a revenue of $76,000. The point I am getting at is, that if you and I owned the works and got that amount of revenue from the water furnished the public, in addition to the revenue obtained from the water furnished private consumers, it would be better and cheaper for the city to own the works.

On motion adjourned.

Morning Session, Thursday, July 14th, 1887.

Meeting called to order at 10 o'clock, by President Jones, who read the following letter:

Pawtucket, R. I., July 1st, 1887.

Hon. B. F. Jones, *Pres't of Am. Water Works Ass'n:*

I write to inform you that I shall not be able to attend the Convention at Minneapolis on the 13th inst., owing to sickness in my family. I have a son 21 years of age, who has been apparently well up to this time, but last week, Friday, was taken with bleeding from the lungs, and has since raised large quantities, and is in a critical condition. I regret the circumstance very much, as I had anticipated much pleasure at the Convention.

I trust you will have a grand time. Should any think I have lost faith in the old American Water Works Association, you can assure them that I never forsake my *first love*, the "American Water Works Association." I hope you will have a profitable meeting, and that we shall continue to grow in number as well as knowledge, for I believe our Association is founded on principles which, if properly developed, will produce results that will be appreciated, not only by the scientific mind, but by the American people at large.

Please extend to the Association a cordial greeting from the N. E. W. W. Ass'n, which I have the honor to represent, and wish you a God-speed in your laudable undertaking.

Very Respectfully Yours,
EDWIN DARLING,
Member of the A. W. W. Ass'n,
and Pres't of the N. E. W. W. Ass'n.

Mr. G. W. Pearsons then presented a paper entitled:

NATURAL FILTRATION.

Question. Is it practicable, as a rule, to depend upon a water supply drawn from the gravel or sand, under or adjacent to a stream?

The title of the subject allotted to me, and the question, seem to cover both quantity and quality.

In the Journal of the New England W. W. Association for June, Mr. Albert F. Noyes, City Engineer of Newton, Mass., gives a very valuable paper on driven well supply. Another by Professor Trowbridge, on the Auxiliary Supply of Brooklyn, is given in Engineering News of May 21st.

The programme of our present meeting gives three papers upon cognate subjects. In the one allotted to me, a better authority was called on, but could not respond.

The attention given the subject outside of text books, shows its importance, and the need of something more than can be given by a single individual in the compass of a paper.

I hope that Col. Fanning will be able to take up this subject, not only for our benefit, but of the public at large; what we need is a text book in which may be collected all the information accessible; the writer of a paper can not properly collect from text books or the labor of other writers.

The difficulty in making such studies lies in the unreliability of second hand information: very few persons realize the great quantity of water required for city supply, and think a well which would supply a few families, adequate for the supply of a city.

In a conversation with the writer, the late Mr. Henry R. Worthington observed that he had pumped out so many inexhaustible wells that the mere mention of procuring a supply from such a source made him nervous. (I think he said tired).

The writer is very much inclined to generalize, perhaps too much so, but this question does not admit of a general answer; it would be very pleasant if an affirmative answer could be given, but unfortunately the most general one would be in the negative, and those favorable localities where such a supply can be obtained cannot be ignored.

The compass of this paper includes only such supplies as may be drawn from streams by the use of the natural ground as a filtering medium, but it is difficult to say just how far from a visible stream we may go, or whether those supplies which are drawn frow invisible accumulations of water in areas of sand or gravel, should not be included; they are a factor of as great value as the first, and as the means of obtaining a supply from them is similar, it seems proper to draw no line between them. The most important supply now drawn from underground in this manner is probably the auxiliary supply of Brooklyn, L. I. When this is examined it will be found to be only reaching for more of the same supply the city had before.

Ordinary sand or gravel of somewhat uniform character has interstices to the amount of 30 per cent. or more of its volume; compacted by the wash of the sea, the smaller particles naturally filling the void between the larger, and further condensed by centuries of pressure from the superincumbent mass, it is doubtful if the voids exceed in the aggregate 15 or 20 per cent.

On the sea beach at Long Island, the writer has observed the water of a heavy storm sinking into the sand as fast as it fell: Further inland, the surface soil and vegetation retards the descent of the rainfall considerably, still, a very large per cent. passes into the ground: The mean annual rainfall of this locality is some 42 inches, of which it is probable that considerable more than 50 per cent. sinks, say 24 inches per annum, or enough to fill the voids in the water bearing stratum to a depth of ten feet or more.

This moves o a gradient of from 5 to 7 feet per mile, steadily seaward, enough passing off each year to make room for the yearly accretion.

Neglecting the study of its passage in detail, consider that a mass some 200 feet in depth, takes on this motion: How much greater the movement is at the top, we do not know, but as water moves in the line of least resistance, we may naturally consider that the greatest movement is near the surface. The average would be some 3000 feet per year, or say 9 feet per day.

At the wells, Professor Trowbridge found the movement about one foot per hour. The same study shows that over 200 millions of gallons can be drawn annually from each square mile of such ground. This rate of flow of one foot per hour, given as the equivalent of a head or slope of from 5 to 7 feet per mile, seems to be the movement of the contained water, that is a movement of about 2½ gallons through each square foot of the area traversed. This accords reasonably well with the former analysis, and is the writer's understanding of Professor Trowbridge's paper.

In artificial filtration we reach a maximum of some 5 times this amount, that is a cubic foot of water per hour per square foot, with a clean filter, but soon decreasing to perhaps half this. It is evident that clean material will allow a much greater rate of motion through it than when it has become partially clogged; it is also evident that the motion of the water must be so slow that the suspended particles of impurity may be at liberty to attach themselves to any solid substance with which they come in contact on their journey, and not be again displaced by the action of the moving current.

The action of coagulants, alum, iron, muriatic acid, &c., seems to add very much to the rate of motion available for filtration, as would be naturally inferred, the aggregation of particles in this case making them much readier to seize and hold to any solid substances with which they come in contact. I think that Col. L. H. Gardner, of New Orleans, was the first to suggest this as a practical aid to rapid filtration. I make the statement from my own understanding of the matter. Brother Gardner can deny the charge if he chooses, but otherwise I think we must hold him responsible. Be this as it may, it would seem that some of the principal builders of filters have been enabled by this simple addition to the ordinary process of filtration, to add very largely to the efficiency of their filters.

The writer would here note that the experiments of Col. Henry Flad, of St. Louis, and his own, show that when the action of filtration is upward instead of downward, a large body of still water being below the filter, the action of gravity on the particles rejected by the filter, tends to deposit them in the still water, and the filter is much more effective and permanent than with the usual downward flow. It may be objected that the writer is wandering from his subject, but it is probable that the other writers on corresponding subjects will likewise wander from theirs, they having so much in common.

If we agree on any point it helps to establish that point, if we disagree, the meeting can note points of difference and make their own decisions, so that it can not be considered as lost effort if we do to some extent trench on each other's subjects.

Under or on the banks of streams, galleries have been built with a view to obtaining natural filtration; where the current is at times so strong as to wash from the bed of the stream the silt, which has been deposited by a lower stage of water; the action of these galleries is similar to that of an artificial filter, where the surface of the sand is covered with a less pervious material, which remains in situ, it may be doubted whether the most of the supply comes from the stream.

Bear in mind, that all ground water is primarily derived from rainfall, that in every case the stream is the natural drain-

age of the area traversed, that all ground water tends in this direction, and it is evident that the rainfall on this ground passing underground to the stream, is a greater or less factor of the supply. In the Northern States, water bearing gravel beds are found which may be very valuable as sources of supply.

At Peoria, Ills., a small well near the river was sunk through hard clay into a stratum of coarse gravel and boulders of unknown depth or extent. This yielded some three millions of gallons per day, and the amount available seems unlimited; so far as the writer is aware the quality is good for city supply, but I have not heard of its having been utilized for this purpose.

In Alleghany County, New York, the Genesee River passes through a similar formation. At Binghamton, New York, water is drawn from a similar source. In Kansas an immense deposit of sand and gravel seems to exist over a large area between the Platte and Kansas Rivers; the Kansas lying in lower ground draws a large portion of its waters from this source.

It would seem probable that these deposits occupy the channels of former rivers, and that we may find them away from, as well as adjacent to streams, or some of them may be deposits of supposed glacial drifts like that of Long Island, in any case when we find such a deposit it is worth testing if we are after a supply, but it is only by testing that either its quantity or quality can be known.

At Marshall, Mo., the writer found a water bearing sand deposit some 20 feet in depth, its apparent breadth was something less than a mile, its length unknown. At a depth of 30 feet, bits of wood, bone, coal, &c , showed very clearly that its origin was comparatively recent, but evidently prior to the present make up of the country.

About a quarter of a mile below this well there was a living spring where the sand stratum cropped out in the ravine. During the sinking of the well, the pumping necessary for the work dried the spring, showing that the flow of water past us was arrested by the depletion.

The well was 36 feet in diameter and about the same in depth, the object of this size being to store water for sudden call. It seems able to supply permanently some 200,000 gallons of water per day.

The sides of the well for 10 feet from the bottom are made of cants of 3 inch plank, kept ⅛ of an inch apart by veneers of wood, giving about 1000 square feet of percolating area; during the sinking, however, all the water came from the bottom, the well was accordingly stopped 3 feet above the hard pan bottom, and the sand and gravel covered with stone, through which the water might find its way to the well. This is mentioned from the fact that it corresponds with the usual practice in filtering galleries.

In looking over the records of these it becomes evident that the bottom of these galleries is generally considered alone, with regard to the entrance of water to them. Any inlet from the sides needs very careful guarding to prevent the admission of fine sand, which is more easily kept back in the bottom by the aid of gravity. Further than this, it seems that these galleries are not largely increased in capacity by added dimensions, few of them are more than six feet in breadth. Where the volume

of water in these galleries is of value to answer sudden call, the expense of their construction may be justifiable, otherwise the system of groups of small wells is cheaper, and will evidently yield all the water available in the locality.

The particular method employed to procure the supply is of less consequence than the fact that such a supply is available. The auxiliary supply of Brooklyn is drawn from between 300 and 400 ordinary driven wells, located for convenience at natural water courses, the depth of wells and required lift being least in these localities. Such a group of wells will probably secure all the flow for a mile or more on either side of them, porvided that their nearness to the sea shore does not render them liable to deplete the water level so much as to bring in sea water.

Jamaica Bay, on Long Island, is an irregular indentation, some four miles in width; outside of this is a long sand point (Rockaway) averaging perhaps a quarter of a mile in breadth; the writer was called to provide a water supply on this point.

As it was some seven miles to the nearest land where water could be obtained by the process adopted for the auxiliary supply of Brooklyn, or else four and a half miles under the bay to the Brooklyn aqueduct, with a very doubtful chance of being allowed to draw such a supply from the ground there, the writer decided to try what could be found on the point itself, especially as works had to be built there any way, and would not be lost if it was found afterwards necessary to go ashore for water.

The surface of the sand spot was irregular, the sand dunes and low places alternating. Where any considerable area existed which was not overflowed by exceptional spring tides, the water in the sand was found sweet and good, in the low places, brackish. A well on good ground near the bay was used for the supply of steam tugs, during wet weather it gave good water, in dry weather it became brackish, evidently drawing a part of its supply from the sea at such times.

On this point the writer put down 46 wells, dodging the low places and getting the best locations available over about a mile of ground lengthwise of the point.

The wells were open, that is, not connected by air-tight connections to the suction main. They were found capable of yielding from 20 to 30 gallons per minute each, but were gauged to 10 gallons, each well being sufficient to yield that supply without depleting the ground water to the extent of the average rain fall.

The frictional resistance of the water on its passage from the more distant wells to the pumps was made as nearly equal to that from the nearest, as practicable, and each well was further controlled by a valve between it and the suction main; the first effort in pumping show less than six inches difference in the height of water in all the wells attached.

They were from 6 to 8 inches interior diameter, a part were made by casting the lower joint open, covering the cast iron with heavy galvanized iron wire cloth of $\frac{1}{4}$ inch mesh, and this with brass wire of 50 mesh. They were sunk by putting down an outer tube to the depth required, lowering this to place inside and drawing out the outer tube, as such tubes could not be sunk by driving, without destroying the covering. The rest of the wells were of perforated tile; to put these down, an outer casing about one foot larger than the tile was sunk two feet

deeper than intended for the depth of the well, two feet of the bottom was filled with gravel, the tile, of which about four feet was perforated having been previously cemented in the joints, was now carefully placed in the center of the casing and filled in with gravel to about two feet above the perforations. The outer tube being now withdrawn left the tile bedded in gravel. These were the best and cheapest. All the wells were sunk ten feet below the water surface in the sand.

The reason of describing this plant at length, is that in several cases groups of wells like those driven alongside the Brooklyn aqueduct have been tried on the Atlantic seaboard and some of them have proved failures. The reason may be found in the actions of the well cited as used for the supply of tug boats.

Where wells are connected directly to the pumping plant it can be readily seen that those nearest the pumps, by reason of difference in friction, will be drawn on most heavily, and the pumps can not discriminate, therefore a depletion may occur which will lower the ground water so much as to bring in sea water.

With the open wells the whole plant can be examined and tested at any time, and if any well is yielding bad water it can be stopped without interfering with the rest.

I believe that I am the inventor of this system, and that it does not interfere with any of the driven well patents. You can dig the wells in any way you please, and are entirely welcome to any information which this may give. I have not taken out any patents on it.

With regard to quality, we have, unfortunately, as uncertain a problem as in quantity. Filtration presupposes no objectionable qualities in the filtering medium. At Kalamazoo, Mich., the writer placed pumps over a natural spring which has been enlarged into a well, the flow was from sand, the water of crystal clearness, but so hard that it would deposit incrustations of lime on pebbles in the stream.

In the valley of the Missouri and Kansas, at Kansas City, hundreds of wells have been driven and sunk in the alluvial bottom land, and the apparent character of the sand deposit which they penetrate would seem to insure good water, but not one, so far as the writer has knowledge, has given water of a satisfactory quality.

In sinking the sunk well, at Quindaro, for the supply of Kansas City, we found the water raising and falling with the Missouri, some 600 feet distant; the well, 30 feet in diameter, was able to yield some 500 gallons per minute, but notwithstanding it has been pumped all this year, with a steam pump, for the supply of all the works, at times furnishing over 100 masons and concrete men, it retains its characteristic taste and the men will not drink it.

All along the Missouri, wherever I have learned of the characteristics of the ground water, the same report comes of unfitness for supply. Along the Mississippi, below St. Louis, where the planters thought they had solved the question of water supply by driving wells, the outbreak of ague followed their use, and they had to be abandoned.

It does not seem possible that all the wells so driven have proved bad, but the reports which the writer has heard for the last dozen years have been remarkably uniform.

The writer therefore considers natural filtration a very uncertain dependence, best probably where the distance traversed by the water is least, and depending very much on the purity of the filtering medium.

In some localities valuable supplies may be had from such sources, but in the alluvium of our southern and western rivers such a supply, if obtained, is liable to be doubtful in quality.

MR GARDNER:—I think it would be highly interesting to all who were not at our last meeting to hear a description of the present water supply at Denver.

MR. BEACH:—At the convention held at Denver last year we were most pleasantly entertained by the Denver water company. We were taken through the pumping works and shown its perfect condition, and to their reservoir, where, by the aid of the electric light dropped into the water, the fish were plainly visible at a depth of eight to ten feet. From there we were taken to the source of their supply, about four miles up the river. The water supply of that city, which is one of the clearest and purest in this country, is taken directly from the Platte river by means of underground galleries, about fifteen feet below the surface. These galleries, as I understand them, consist of branch pipes or conduits of wood, branching off at an angle or V shape from the main conduit. These are perforated with an auger to admit the water which percolates through the gravel. At the junction of these galleries with the main conduit wells are placed through which either may be entered for examination or repairs. In the event of the closing of the auger holes or insufficiency of supply it is but a simple matter to add more holes. From these galleries the water is carried through a forty-eight inch conduit to a reservoir with capacity of twelve million gallons, which is located at the pumping station. These galleries or conduits, which are of wood, are made with staves and hooped as a barrel. The flow is from ten to twelve million gallons per day. This system, I am told, is the invention of their Chief Engineer, Mr. Charles P. Allen. It seems to be a perfect system, and there is no doubt, whatever, but that in this case the water obtained is by percolation through the underlying sand and gravel from the Platte river. Whether a similar system would be practical at another place is a question.

The author of the paper just read spoke of the water of the Missouri Valley. We have a well at Pierre, Dakota, on the bank of the Missouri river, the water in which rises and falls with the river.

We first sunk a well which we found too shallow, the water given was insufficient to supply the pumps; we then went thirty feet deeper through sand and gravel, and the additional water thereby secured necessitated the increasing of the pumping capacity, which has reached one million and a quarter gallons in twenty-four hours. When the Missouri river is at its very lowest point we have plenty of water. The well is practically inexhaustible, and the water is found to be as pure as ground water can be.

After running steadily for two years we cleaned out the reservoir, finding not over a pint of sand, which was the only sediment we found.

My experience is that where it can be had natural filtration is equal to any filtration that can be maintained.

I would like to hear from Mr. Troy.

MR. TROY:—Our well at Pierre, Dakota, was sunk one hundred and fifty feet from the bank of the river, and was at first sunk slightly below the low water line of the river; this not giving a sufficient supply of water we sank another well inside the first one; the latter, a well of seven feet in diameter to a depth of twenty feet below the bed of the stream; the top was covered with wire gauze of sixty meshes to the inch, through which all the water passes. We have found that, with the river at its lowest stage, it was impossible to pump it dry. The water is as clear as crystal, and a chemical test has proven it to be practically the same as that of the river.

The material through which the well is sunken is coarse gravel from the size of a pea to that of a hen egg.

MR. GARDNER:—I have noticed that there is a crust forms on the banks of the lower part of the Mississippi that makes it almost impossible for the water to percolate through it.

Some two years ago the Electric Light Company at New Orleans dug two wells within 800 feet of the margin of the river; they got an abundant supply of water, but it was not river water; it was surface water, and not percolation from the river at all. The deposits from all the vaults of this establishment go into the well and is purified by artificial sand stone filters.

It depends altogether upon the locality and the neighborhood of the stream whether you get percolation.

MR. HODGKINS:—I have never had very much experience in this matter, but the remarks of the gentlemen prompt me to ask them to throw a little light on this question, Why is it that these wells are placed near the

bank of a river? Second—What object can there be in taking the water through the well at all? The answer that comes to my mind is, that the water percolates from the streams. I never thought that the water in the well rose and fell with the water in the streams. My own experience leads me to think that the reason they are located on the banks of the river is that the water may be taken either from the well or the river without moving the machinery. I have never been able to discover any better reason for it.

Now the question as to whether the water comes from the stream into these wells: I have an engineer at Peosta, who complained that he could not get any water; that the water flowed from the well into the stream; and we had to make an open channel before we could get any. Now, if it is a fact that we do get river water, what do you want with a well? Why don't you run your pipe into the river?

MR. BRIGGS.—If the gentleman were familliar with the waters of the Mississippi, Kansas and Missouri rivers, he would know why the water was taken through wells, and not direct from the river. For the benefit of those not so informed I will state that for a good portion of the year, the water is fearfully muddy, and in pumping from the river, to get a little *water,* you must take a great deal of mud. We therefore sink wells with the hope that we can draw the *water* through the gravel and leave the mud behind.

MR. RINKER.—In the majority of the Kansas rivers, the gentleman refers to, the water is better before it passes through these filters than after; the same, I think, may be said of the rivers of Minnesota. Take, for instance, the sun-cured water of the Minnesota river and it is better and clearer than the water which percolates through the soil or from the lakes. We have a great many lakes in Minnesota, and the question frequently arises as to the propriety of taking this lake water for domestic supply, on account of its purity. You can get the water from any of these lakes within a radius of forty or fifty miles, but we find that this water taken from almost any depth, is polluted with the fungus or vegetable growth, which has decomposed in the lakes.

I am a little inclined to feel as Mr. Hodgkins. Why, if water from the river is the best, do you not take it directly from there, and resort to artificial methods to get rid of the mud carried in suspension?

MR. ESPY:—We tried the experiment, at Wilkesbarre, of sinking a well a short distance from the river. We found the water freed from vegetable matter, which was found to a certain extent, but it did not filter out one-half of the mineral impurities. The Susquehanna river, as you probably know, is quite heavily charged with sulphur, iron and other minerals, and I do not believe there is any such thing as filtering them out, certainly not by this form of natural filtration. If there is, and any gentleman here can inform me on the subject, I would be pleased to hear from him.

MR. DENMAN:—One gentleman asked why we put the wells near the bank of a river, I briefly answer that we do not. A well has no business near the bank of a river, except as a matter of convenience. The city I came from is now somewhat noted for its pure water, but it was quite different a few years ago, when our water was roily and impure. We found refuge and safety in the use of ground water furnished, (if you please), by means of natural filtration. We dug a well fifty feet in diameter and thirty-six feet deep, but did not get near water enough to supply the city. We had recourse to the river into which flows all the drainage from barn yards and from the farms above.

It seems to me that there is no stream so liable to pollution as a river flowing through an improved country. As I have said, our well was not sufficient, and our directors were at their wits' ends as to how they could supply the deficiency.

We were doing the best we knew how. We were unrestricted by want of means. The only restriction was in lack of facilities. Our directors were racking their brains for a plan by which the city could be adequately supplied with water, and they finally determined to construct another well, but before doing this an officer of the company was sent to visit other cities, consult hydraulic engineers and generally post himself on the subject of water supply. Dayton, Columbus and other cities were visited with much profit. In a New York publishing house (Van Nostrand & Co.) was found the ninth annual report of the Massachusetts Board of Health, prepared by the late Professor Wm. Ripley Nichols, and in which was found a very valuable paper comprehending the subject of ground water. Our board decided upon the gallery or conduit system, and this has been in successful operation since September, 1883, and has furnished all the water pumped to the city of Des Moines since that date. Our

gallery is about eleven hundred feet long, constructed of white elm, and runs through a bed of coarse gravel which is reached at a depth of about twenty feet below the surface. It is apparently furnishing more water now than at first. The flow has been but little diminished and never reached the danger line during the long and unprecedented drought of the last eighteen months. We are not apprehensive of the clogging of the gallery, as our friend Pearsons has suggested might occur. On Long Island Sound the fishermen, after a long day spent in fishing, coming to the shore tired and thirsty, dig away the sand and find a spring of clear and beautiful water which is covered twice each day by the tide. We see no reason why a gallery running through the sand should be any more likely to clog than these springs. We believe that we get no water from the river into our gallery, and indeed it is questionable whether a well dug in the middle of the river and the flowing water excluded, would produce a particle of river water.

By your permission, I will read a paper sent me by W. C. Conant, of New York, entitled,

"NATURAL FILTRATION" REPRODUCED.

Natural Filtration is a subject of immense importance, for it is certain to be the basis of any effective means for purifying water artificially. It is also a subject of the freshest interest at present, from the fact that we are but just beginning to understand it and apply it. Not having had the privilege of hearing the regular paper, by Mr. Pearsons, I hope that in presenting a modified aspect of his theme, I shall be pardoned if I unconsciously repeat or impugn anything already said.

When we come to understand how complex a process is natural filtration, and how fine and rare is its standard product, we are impressed by the obvious fact that natural filtration, like natural vegetation, was not intended for man's ultimate supply, but was given as a model for him to follow, fill up and perfect, in his great office as the intelligent head and lord of the creation. Rare specimens only of perfect water are found, even by boring thousands of feet into the earth. Of tolerably pure and wholesome water it is impossible to find ready made supplies for our growing and multiplying cities. But it is open to us to learn how Nature produces her very choicest waters, and to do the same. (After having done this, a harder task remains, to get the fact accepted by the public.)

It has been thought that water was simply strained pure, through sand and rock filters. It is now well known that filters by themselves, whether in nature or in art, cannot cleanse water of the worst of its chemical, organic or organized contents. It has been thought that water might be purified by distillation, and that hence rain should be very good water. But the chemist who requires strictly pure water must guard against volatile

impurities that will go over in the aqueous vapor, and that do arise in the clouds, and descend upon the earth, in vast quantities, from innumerable sources on land and sea. Every inch of rain that falls on a square mile of ground carries in it tons, literally tons, of impurities, of every imaginable kind; both such as have risen in the vapor itself and such as it has gathered from the atmosphere. Prof. Charles Mayr says that in such an inch of rain there will be nearly half a ton of salt alone, and an appreciable weight of silver, among other minerals, and all manner of soluble gases, etc., in immense volume. Rain water, after all, is nature's dishwater, from washing the great bowl of the atmosphere, that else would be a poisoned bowl for every animated creature.

Again, boiling has been and is still much recommended as a means of making water wholesome. But, like the other methods, this is only a partial remedy. Sir Benjamin Brodie tells us that organic impurities are destroyed only by boiling in corrosive acids; and according to Frankland, organic germs are many of them unaffected by high degrees of heat or the most powerful disinfectants.

Finally, oxidization is a cure-all, according to some pretentious authorities. Oxygen decomposes almost everything; but atmospheric oxygen is fortunately neither active enough to purify water in a hurry, nor intrusive enough to penetrate it in force without great pressure; otherwise there would be little left of nature or man but oxides and ashes. A cast iron stove might be reduced to dust by oxygen, in time, and so might the impurities of water be transformed; but is doubtful whether even exposed and agitated water would not usually absorb fresh impurities from the atmosphere, in most situations, about as fast as the oxygen of the atmosphere would eliminate them. Free oxygen, with which chemists determine impurities, is not employed in nature. The amelioration of polluted streams in the course of their flow, once hastily attributed by some to oxidization, must be otherwise accounted for, if chemical experiments tell the truth; and there are not wanting a number of conditions in the flow of streams, that abundantly account for all the purification they get in that process. Besides the greedy absorption of impurities by aquatic vegetation, animalculæ and fishes; besides the large dilution of the growing river; besides the constant exhalation of gases from the decomposing filth; besides the adhesion of large accumulations to solid surfaces such as stones and timber, wherever they are encountered; besides all these and other causes, the beds of polluted streams bear witness wherever they are quiet, to the precipitation of great quantities of both suspended and soluble matter, through the agency of that which is the chief auxiliary of effective filtration, natural or artificial. That great auxiliary has but recently begun to be recognized in the circles of science itself. It is the chemical-reactive and the mechanical-coagulative virtues of the mineral salts that are universally distributed in the soil (whence they are constantly washed into streams) for the double purpose of detaching impurities from water, and converting them into nourishment for the finer orders of life. The salts of iron, calcium, potassium and aluminum are nearly ubiquitous, and the latter two, usually in combination, in common clay, take the leading place all over the world in the preparation of pure spring and well waters, wherever they are found. This great

purifier has a remarkable mechanical power to gather into masses the fine suspended matters which practically cannot otherwise be settled or filtered out. But far more important still is its chemical agency in transforming and separating from water the soluble organic contents whose structure is finer than the water itself and that will go wherever the water can go. Prof. Kedzie of the University of Michigan, says: "The tendency of all aluminous compounds to form double salts, imparts to clay a chemical activity of singular power. When a dark colored and strong smelling solution of manure is filtered through a clay soil, the whole of the coloring and odious matter is withdrawn from solution. The solution is not only physically altered: its chemical composition is changed: ammonia, the soluble phosphates and most of the potash, are withdrawn from solution." In refining sugar, the effect of clay on the dark and rank ingredients of the raw material is precisely as above described. It is related that the discovery was first made through the unwelcome intrusion of some fowls, with clay on their feet, upon a quantity of brown sugar that had been spread out to dry. It was observed that the clayey feet had made white prints through the brown sugar, wherever they stepped.

So lately have we begun to appreciate the power of these grand water scourers from the soil, that few perhaps, are as yet prepared to recognize their leading agency in the purification of streams by the precipitation of both suspended and soluble organic pollutions. Few as yet recognize their indespensable intervention to separate and coagulate such impurities for immediate exfiltration by the sub-soil sand, in the case of the ground water that percolates downward to supply wells and springs. But the more they are examined and tested by experience, not only in the laboratory, but also on the largest scale of practical operations, the more we are impressed with the marvelous potency and subtlety with which very minute proportions of these earth salts, particularly the aluminous, as Prof. Kedzie has remarked, will pervade, instantaneously, large quantities of water. What becomes of them, is a question that need not be asked by any one who has looked into an elementary school book, so far as to apprehend one of the most palpable results of a chemical reaction—the disappearance of the transforming re-agent in the new and totally different substance produced. With the exception of the calcium and magnesium salts, and occasionally the iron, there is hardly ever in refined natural water any sensible trace of the refining ag nt; which seems to be always just enough, simply because an infinitesimal proportion suffices, which would not be perceptible even if wholly left in the water.

Indispensable, however, as the soil chemicals are for perfect filtration, it must be acknowledged that sand and coke, properly employed, seem to develop purifying powers that have not been appreciated nor accounted for. Recent developments are remarkably significant on this point. Dr. Frankland's biological tests of filtration for the exclusion of micro-organisms are astounding to our preconceived philosophy of the subject. Notwithstanding that these germs are so much smaller than the interstices of the filtering materials that they might play hide and seek in the labyrinths with the greatest freedom, Dr. Frankland finds that very few pass through in the filtered water, and if the filter be loosened up and cleansed frequently, it is in good

measure a defense against them. His conclusion is that since they certainly are not caught in the crevices between the particles of sand or coke, there must be a surface attraction of those particles, which causes bacteria, as well as other suspended matters, to adhere to them. In a certain large way, this is in fact a matter of common observation. The accumulation of muck and slime on submerged surfaces is familiar to everyone.

Grouping the several co-operating agents in nature that we have surveyed, we have a complete view of Nature's pure water-works. First, the distilling and pumping works of the atmosphere, evaporating, conveying, condensing and discharging a partially purified element from every source of moisture, even the foulest; but taking by the way the opportunity to wash itself (the atmosphere) in the same before parting with it. Second, the chemical works of the soil, absorbing, transforming, separating and coagulating, the numerous impurities of the rain as it percolates to the sub-soil sand. Third, the fine and compact sand filter below the soil, which is now able, thanks to the chemical works above it, to arrest near its surface the minute but no longer intangible particles that have been changed and coagulated by the alum in the clay. I do not forget the work of other sulphates, of the carbon and carbonates, of the phosphates, etc., but need only allude to them, for the present purpose.

It is necessary, however, that we attend very particularly to the filter-cleansing apparatus of Nature, without which, or its equivalent, no pure water could be continuously produced. This is the work of vegetation. Nature accumulates no layer of filthy muck on the upper surface of her filter bed, such as covers the bottoms of our "settling basins" and artificial filter beds, to make corruption worse corrupted, and breed both exhalations and organisms of the most noxious character. All the subsoil stratum is kept clear and sweet, purified for its purifying office through the prompt absorption of every separted and exfiltered impurity by the deeply pushing filaments of plant life. An artificial filter that is not, like this, constantly self-cleansing, is a danger, rather than a defense, to the health of those who drink its infusions.

A water supply that is muddy with suspended earth may be improved by a settling basin or a standing filter bed, provided there are no organic impurities to speak of. But when the water is (as usual) more or less contaminated with decaying organic matter, animal or vegetable, the sooner it goes into the stomachs that are to receive it, the better for them. Every day's detention in a settling basin, especially in summer, serves to ripen the rot, and develop at an enormous rate its most pernicious product, the microbes of zymotic disease. That which settles is in the long run most injurious of all. Nobody who has smelt the muck at the bottom of a settling basin or filter bed should need evidence on this point. To collect and preserve in a reservoir of drinking water, immense masses of the worst filth obtainable, as the bed and basis of a community's drink, is certainly the strangest of all the anomalies of civilization. To clean out such a compost once in six months or a year, is only to remove it after it has done its worst, and to make room for a reinforcement of the same sort. The Poughkeepsie filter beds were scraped at intervals to remove the surface accumulation of filth, yet eventually became so saturated with it that filtration became obstructed, and last year

it was necessary to remove and renew the whole bed of sand. According to the report of Mr. Fowler, the Superintendent, the interstices of the bed had become packed with the river muck, through and through, in a dense mass-like compact loam, and about as impervious to water. The bare thought of drinking an infusion passed through such a mass is a horror. In the opinion of the best sanitarians at present such filtration is worse than nothing, and the appearance of purity in the watar is a delusion and a snare.

Fourth, the finishing work of oxidization. The best water is that which has gone deepest in the earth, where there is the tightest pressure, atmospheric and telluric. Continued and intensified filtration has refined it; but it is here, and not in its open-air exposure, before or after, that the water gets effective oxidization. The remarkable fact that water absorbs oxygen in something like a geometrical ratio to the increase of pressure, coupled with the other equally important fact that under a certain pressure and temperature organic germs cease to exist; both these conditions protracted for the water by a long detention in the depths of the earth, secure the rarest refinement and also vitalization of the element.

Man also can do all these things. Having gathered the impurities of rain and surface water in the grasp of chemistry, and mechanically arrested the massed combinations with filters of fine compact sand and carbon, continually recleansed, we can finally put on all the pressure of oxygen desired, continue it as long as desired, and produce water that will do new honor to nature through her son and lord.

THE PRESIDENT:—If there be no objection Col. Gardner will now read a paper by J. D. Cook, entitled:

FILTRATION OR SUBSIDENCE.

THE MOST PRACTICABLE AND ECONOMICAL METHOD OF OBTAINING A SUPPLY OF CLEAR WATER FROM STREAMS CARRYING CONSIDERABLE QUANTITIES OF SILT.

In submitting for the consideration of the Association such thoughts as occur to me relative to this troublous though permanently important theme, based upon somewhat extended research and painstaking investigation, both theoretical and empirical, I am not unmindful of the fact that the subject, notwithstanding its multifarious attributes, may be considered as to some extent a hackneyed one; that the realms of chemical science and many of the brightest engineering minds have from time to time been brought in requisition for its safe and satisfactory solution. Inferentially, the discussion of this topic necessarily takes wider range than the comparative merits of the two systems under consideration—for the mere clarification of turbid waters from running streams; a result which under average conditions can generally be accomplished by either process—variable only as to time and with the distinctive characteristics of the objectionable constituents held in suspension, while solu-

ble coloring matter, as a rule, is practically irremovable by either, or by any other process short of chemical agency. In the case of ordinary filtration, the theory seems a tenable one, that under certain conditions, such as long usage, unfrequent cleansing, &c., the filter, while uniformly producing limpidity and apparent purification, may in reality become a dangerous source of contamination. The fact of effective filtration of sedimentary water pre-supposes a proportionate clogging of the filter—gradually though steadily reducing its filtering capacity, by retaining the lees or residuum within the interstices of the filtering material—a portion of which, if not speedily and thoroughly removed, tend to harden and become attached to the material—permanently retarding the flow, while another portion is subject to decomposition into soluble gases, their nature and origin depending upon the primal nature of suspended impurities, whether mineral, vegetable or animal, and contaminating the subsequent filtrate with constituents vastly more harmful and also irremovable by any process short of actual distillation.

It is claimed with more or less semblance of logic that organic impurities, or the major portion of them, are absorbed and neutralized by the use of charcoal, animal and vegetable, "spongy iron," coke, &c., as a filtering material, that such material, especially charcoal and possibly coke, will absorb gases to the extent of about eighty times its own volume. Nevertheless we are unable to reach anything like a satisfactory formula for determining the volume of water that will be actually purified through such agency; or the length of time required for charcoal to become fully charged and inoperative as a purifying agent,—when it will cease to act chemically and become like sand or other filtering material, simply a strainer for removing suspended sediments, conditions which can only be determined by analysis; conditions under which the filter would produce the two-fold result of simultaneous clarification and contamination. The somewhat generally accepted theory that limpidity means purity being demonstrably illusive, as some of the clearest waters are notoriously the most impure; the outflow from a sewer, for instance, excepting in times of flood and during flushing, cleansing, &c., is usually "crystal clear," while carrying in solution the most dangerous constituents.

The great difficulty and danger, therefore, in artificial filtration is due to the frequent necessity for thoroughly cleansing the filtering material. In adverting to this all important and vital desideratum, I am reminded of the following editorial in the *Sanitary Era*, October 2d, 1886, which seems worthy of reproduction:

"It is long, even in our own memory, that filters of various kinds have been recommended and sold, tried and found wanting. The best report of them was that they worked nicely for a while, but the inevitable sequel was a failure. The result of all this experience is what might have been expected: those who have had the most to do with filters, those who need them most, those who were once the most hopeful of benefit from them, and those who are now most invincibly prejudiced against every evidence of successful filtration, are generally the same parties. *** The great, persistent element of failure in filtration has been the saturation of the filtering medium with impurities, for want of

any way to keep it clean while acting as scavenger to foul water. There were ways more or less practicable to clean the filtering medium or to substitute a fresh one. But to clean it after it is fouled, is not the thing; we must keep it from being fouled. They clean (or call it cleaning) their filthy filter beds in Europe, once in a few months, by scraping off the surface acres of putrescent muck, and covering the somewhat less offensive mass beneath with a layer of fresh sand."

It is both improper and far from my purpose in the necessarily hasty preparation of this paper, either to portray the merits or to criticise the demerits of the several antecedent or present devices for artificial filtration. The older and still the more extensive systems having been designed by, and constructed under the supervision of engineers of great experience and universally acknowledged ability—some of whose names are still among the most honored in the profession—while the more modern devices are generally covered by letters patent, and ably represented by corporate associations. This has had the effect to largely transfer a troublesome problem from occasional engineering practice into a specialty, resulting in a wider range and more persistent thought, investigation and experiment.

Without intentional partisanship or discrimination, it may not be amiss to mention in this connection, what is termed the "Hyatt Pure Water System," a system which is doubtless more or less familiarly known to most or all members of the Association. It is claimed to possess the triple characteristics of coagulation, filtration and aeration, using alum as a coagulant for the purpose of concentrating, solidifying and rendering insoluble the more objectionable constituents in the water, which are afterwards arrested in the filtering material of sand and comminuted coke, after which the filtered water is charged with atmospheric air under pressure, for the purpose of oxidizing and destroying the remaining organic impurities. The cleansing process consists in so manipulating valves as to force clear water through the material in reverse currents, raising, intermingling with and passing rapidly through the filtering material, with the view of removing the coagulated impurities, by attrition and abrasion, and discharging them into outlet drain pipes.

The use of this or any other known or established system of artificial filtration, in connection with water works depending upon direct pumping or ordinary stand-pipe service, would necessitate a filter ng capacity equal to the quantity of water required during fire service, or a storage capacity sufficient to meet such contingencies; otherwise the pipe distribution would at times be filled with unfiltered water—liable to prove not only objectionable, but also incur more or less expense and delay in blowing off and re-filling with filtered water. In either case a low service pump to supply the filter would doubtless be found a necessary adjunct, owing to the danger of subjecting a large filter to fire pressure, and the inefficiency of filtration under such extraordinary conditions, accelerated velocity, &c.

This subject may be regarded as an endless one, taking in its range an almost illimitable field of research, (of experiment,) of theory and of empirical results; and while it seems safe to assume, as one of the well learned lessons of the past, that artificial filtration on a large scale has as a rule proven more or less unsatisfactory, owing to the intervention of apparently unsur-

mountable obstacles; it may be equally unwise to assume that a result upon which the well being of so many municipalities is largely dependent can never be attained.

In contemplating Nature's grand system for supplying water—so indispensably necessary to the comforts and needs of mankind—we are naturally impressed with the manifold phases which characterise the subject—evaporation, condensation and descent as rain-fall—constant and unceasing transition from pollution to purification, and vice versa. Atmospheric pollutions begin to attack it simultaneously with the commencement of its descent as rain-fall, generally with soluble compounds, organic and inorganic. Terrestial contaminations are carried from the surface into running streams. Subterranean constituents, harmful and otherwise, and of mineral, vegetable and animal origin, are taken in solution during its percolation into the earth—depending for the intensity of objectionable elements upon the degree of earth pollution. But in considering the question within the scope of this topic, we have only to deal with the two former sources of contamination; and finally, the efficiency of subsidence as compared with filtration. Each is claimed as an assimilation of nature, and each requiring artificial attention when applied to the purification of a public water supply. In the one case the sediments are arrested by filtering material, in the other precipitated to the bottom of the subsiding reservoir. In the one case, if left to decompose, increased and irremediable pollution will follow; and in the other, equally deleterious results will characterize the decomposition into soluble gases, which, under the influence of capillary attraction and variable temperature, may again permeate and intermingle with the water, until ultimately drawn to the surface and neutralized by atmospheric oxygen. In order therefore to properly and safely realize the purifying attributes of either system, both the arrested sediments in the filter and the precipitate in the subsiding reservoir, should be thoroughly removed in advance of the possible commencement of decomposition.

Another point of more or less significance is found in the fact that with ordinarily turbid water successful filtration can be greatly augmented by preliminary subsidence. On the other hand, and aside from the question of limpidity, the filter may prove an important adjunct to the subsiding reservoir.

"The filter bed equally intercepts and removes the fine vegetable fibers and the minute organisms, vegetable or animal, which in all river waters prevail more or less during certain of the summer months. The removal of this class of impurities is getting to be considered in England and elsewhere, as of as much importance as the removal of the sedimentary uncleanness, which is more apparent. During certain of the summer months, when the rivers usually carry but little sediment, this forms the chief beauty of the filter beds. The surface of the sand becomes occasionally as much impeded with this matter as with the earthy sediments which more usually clog it, and it is of a nature to taint the water under certain conditions more offensively than the other. The sand filters are, therefore, considered very important instruments of purification in this relation. They become, indeed, screens of the greatest delicacy, intercepting all material impurities, not the least of which are the very small fish, with which all waters are crowded at certain seasons."–J. P. Kirkwood.

A comparatively small, inexpensive filter, designed with single reference to the subservance of above purposes, would undoubtedly prove of great value where the supply is taken from open lakes or running streams; as the accumulation of "vegetable fibers and minute organisms" as mentioned by Mr. Kirkwood, is a fact which comes within the range of my own practice.

In view of the great, and demonstrable benefits resulting from the prompt and frequent removal of precipitated sediments from subsiding reservoirs, and the well known annoyance, expense and delay incident to cleansing them by former ordinary methods, I have adopted in recent practice a system of under drainage, consisting of small openings placed in near proximity under the entire bottom area of the reservoir, and connecting them with pipes (vitrified and cast iron) converging to larger drainage mains, thence into drain wells in the reservoir embankments; all of which are connected with a main conduit extending safely beyond the reservoir into open drainage. By this process the entire bottom area of the reservoir can be simultaneously and frequently drained of the major portion of the deposited sediments, with no other manual labor or expense than the opening of ordinary valves; and during times of great turbidity and excessive sedimentary deposit, the drainage system can be left open, or sufficiently so, to promote the constant outflow of precipitated impurities. By this process, also, especially with some waters, the reservoir and its drainage system can be kept in simultaneous service—supplying clear water from and near the surface, while discharging turbid sedimentary water from the bottom; the several openings in the meantime creating downward currents proportionately accelerating precipitation, and at the same time securing the well known benefits due to agitation. In treating extraordinarily turbid waters, two, three or more subsiding reservoirs should be used, and made interchangeable in service—the water being passed from one to the other, and from the surface—either through pipes, or preferably over wide, shallow, overflow weirs, into a clear water chamber, thence through a thin stratum of filtering material to the pumps and into the general distribution.

I have thus endeavored to advert to the more salient characteristics of the two systems, without feeling called upon to champion the one or to detract from the other. Both may be said to have strong adherents, whose practice and opinions are well worthy of due consideration. For many years, but few, if any, modifications were made or sought to be made in filtering devices, but within a comparatively recent period many inventive minds have been turned toward the discovery of various and much needed improvements with the view and hope of meeting a long felt necessity. Each and all such inventions looking to greater safety, efficiency and economy in this regard should receive the unprejudiced attention and faithful investigation of engineers, superintendents and others in charge of water works enterprises.

Subsidence, too, although involving Nature's great unerring principles, has also for many years been palpably defective in the detail of design, and proportionately unsatisfactory in current service. It is, however, demonstrably susceptible to improvements and added appliances, which will insure perennial success and safety.

When viewed from any and every conceivable standpoint, this great subject is fraught with an importance second to none, if equalled by any of the almost countless questions with which you have to deal, during your incessant, perplexing and arduous home dnties, or that can come within the purview of your joint deliberations.

Mr. GARDNER.—I have been requested to follow Col. J. D. Cook's paper with some remarks on the general subject of Filtration and Subsidence, but I do not know that I can add anything to the opinions I have heretofore expressed before this Association and otherwise. Nor have I made further experiments in support of my views than those described in a paper written for and published in the *Scientific American*. I have had some copies of this paper struck off for distribution at this meeting, and I hope the perusal may interest you.

The most casual reader of current literature on the subject of water purification cannot have failed to note that the use of iron is attracting increased attention in Europe. It is notably in practice at Paris, Berlin, Ostende and Antwerp. The attention of European chemists has been drawn to it, and a paper was recently read before the Society of Arts, (London, England,) giving as a result of scientific observation and investigation that,

1. The invariable result is that the organic matter is altered in its chemical nature, and the albuminoid ammonia is reduced from one-half to one-fifth of its original amount.

2. The water is softened. The scale in boilers is greatly reduced, and not only so, but becomes open, friable, and adheres very loosely to the boiler plates.

3. Under iron treatment, infusorial life is to a large extent removed or destroyed. The development of that kind of microscopic life which causes fermentation and putrefaction is prevented.

The European plan for iron purification contemplates actual contact with natural or prepared ore, or with cast iron borings or turnings. Following this, is a sand filtration for eliminating the surcharge of iron. My preference is for the immediate introduction of a solution of iron into the water, and in such quantity or to such extent as experiment may have demonstrated as needful for the desired purpose, and no more. This obviates the erection of special machinery and the labor and expense of attention to, and renewal of filter-beds, to say nothing of the vast area needed in the case of a large supply for their installation.

I am unable to state the minimum cost of a solution of iron for purifying water, but I feel assured from the

result of my experiments that a plant purifying five million gallons daily can be conducted at a running cost much within one cent per thousand gallons. There remains to be discovered and demonstrated a filtering process or device of equal reliability and economy for a large public supply.

At a meeting of the Philadelphia Engineers' club, in January last, there was presented, with elaboration and blackboard sketches, a full description of the Anderson process, which involves direct contact with borings of cast iron. The table of analyses given in connection, showed that exceptionally bad and even dangerous drinking waters were rendered not only innocuous but wholesome by this method. The organic impurities were for the major part removed, the hardness reduced forty to fifty per cent., and a brilliant appearance imparted to the water. (See *Sanitary Engineer*, Feb. 26, '87.)

This demonstrates the value of iron contact. I am not convinced, however, that this method of contact is the simplest, best, or cheapest. The figures given are wonderfully low, both for installation and current expense. With entire respect, I should say, incredibly low. I am more concerned, however, in the ascertained results. Let it be remembered that filtration is part of the new European system, but that this filtration is subsidiary and accessory. It has for its only object the elimination of the surplus of iron. Just here it is proper to suggest that if that excess be not introduced, its removal from the water will not be called for, and the expense of filtration is avoided.

I must say something of filtration, but I have no hope of expressing any new or original ideas on the subject. It is understood that I speak of the system as applied upon a large scale. It may be possible to accomplish the exfiltration of bacteria, but it has not yet been demonstrated, even by the slow method of the German filter stone or the *buiscuit porcelaine*. I instance these as effecting the closest approximation to perfect filtration on the small scale. If these are amenable to a suspicion of imperfection, what shall be said of the ordinary straining systems? Whatever may be claimed, nothing new in this direction has been discovered for a generation and more. The report of the National Board of Health for 1881, gives the history of an exhaustive series of experiments in filtration, there being used in these tests all the best known media. This report, in common with all scientific investigation on the subject for the past twenty years, announces an utter

failure as a result. Particularly is noted the failure of sand as a filtering medium. And yet, in the popular mind sand is regarded as best, because it is deemed nature's own favorite purifier. Sand is flint or quartz. As a filtering agent it is only a barrier restraining the passage of gross matter which, becoming entangled, is stopped, and eventually fouls the mass. Now let the water passing through a sand filter bed be impregnated with iron, and it strikes me that the expense of cleaning that bed must be largely increased. Iron is the universal bond of stone. It unites with the silica and becomes part of the sharp sand—flint quartz. The water divested of its silt and surplus of iron, goes on its way to the reservoir—acceptable to the consumer beyond a question or a doubt. Let its filter bed stand, however, and in a comparatively short space of time it will become a mass of sandstone; to obviate which result, the most active attention and frequent washing will be necessary.

Reverting to ordinary filter beds and filter galleries, I need scarcely say that they have long since been abandoned as a practical means for the purification of a public water supply. In modern establishments they are entirely accessory, as in the European iron clarification systems. When a public water supply has, by competent authority been declared unclean and dangerous, that source of supply must be treated chemically and its dangerous elements neutralized—or, what is often more practical, be abandoned entirely. Filtering cannot cure it or save it, however pellucid the water be made to appear. Nitrates, nitrites and chlorides cannot be filtered out of water. Albuminoids cannot be strained out. All these are more dangerous than the more common forms of bacteria. All these can, so say the European chemist, be precipitated by the use of iron, and rendered innocuous. Alum, zinc and other coagulants may be effective, but iron is the only defensible agent. If the water supply in question be amenable to any treatment at all, certainly the results of the most recent research favor the iron process. If not amenable to this, then it is mockery to resort to the exploded system of filtration.

But just here a fair spirit of enquiry suggests the questions, "Is it at all necessary to eliminate or destroy *all* bacteria?" "Is it even desirable that it should be done?" "Is not a certain amount of infusorial life necessary to the *life* of the water?" There are bacteria, and there are bacteria. The fluids of our bodies are alive with them, and it may be to our well-being that it should be so. Some waters so impregnated may not, upon close

and careful professional investigation, warrant an unqualifiedly favorable criticism, and yet generations of use may have failed to show, practically and in effect, the impurity of the supply. A public water supply, like lead service or supply pipes, may be made a most convenient and popular subject of criticism by pseudo-scientific men, and be made a convenient open account to which may be charged up otherwise unaccountable variations in mortuary statistics.

Returning to my subject, I would submit that,

1. Filtration as a system for public supply, has long since been abandoned as worthless, ineffective and expensive, and no new development, discoveries or appliances are before the public warranting the reconsideration of a conclusion founded on expensive experience.

2. Iron, as a precepitating agent for all impurities in water, has become known as effective and economical in use and appliance by careful practical and scientific observers. Its use on the large scale has been supplemented by sand filtration, not for the elimination of original impurity, but to rid the water of the effect of excessive treatment.

3. It is in logical order that this filtration, as a subsidiary or collateral treatment, be avoided by the introduction into the water supply, such an amount of iron as will effect the desired result, and no more.

To conclude remarks already too much extended, let me beg water works officials to set before them the problem of the production of a cheap solution of iron, and pending this enquiry to experiment studiously upon the peculiar defects or impurities of their several local supplies with the remedial agent *iron*, and the system of *subsidence* prominently before them.

I claim the honor of being the first to call the popular attention of the American public to the use of iron in a water supply as a coagulating, precipitating and purifying agent. In this I do not claim entire originality. I followed a single hint thrown out by Dr. Gunning, in Holland. At the time of my experiments Bischoff and Spencer were operating with specially prepared iron ore. The Anderson system is a step in advance of this. It remains for America to go still a step beyond, and I predict that step will be a direct application of iron to the water supply without subsequent filtration.

The hour of noon having arrived, adjourned until 2:30 p. m.

AFTERNOON SESSION, THURSDAY, JULY 14TH, 1887.

Called to order at 2:30 by the President, who stated that the subject of filtration was still open for discussion.

THE SECRETARY:—I have here a paper, or rather the latter half of a paper, descriptive of the systems of filtration at Bombay, India, written and forwarded by Mr. Samuel Tomlinson, deputy executive engineer of the Bombay water works, who is a member of the association. Mr. Tomlinson wrote me that he had sent the first installment two mails prior to this, but it seems to have miscarried, as I have not yet received it. Shall I read this portion of the paper?

MR. HENION:—As we are likely to be limited for time this afternoon, I move that the reading of this portion be dispensed with, and that it be printed with the proceedings, together with the missing part, when the Secretary shall have received it.

The motion adopted.

THE SECRETARY:—I am requested to present the following:

THE CIVIL ENGINEERS SOCIETY,
ST. PAUL, MINN., July 14th, 1887.

J. H. Decker, Sec'y American Water Works Association:

DEAR SIR:—The Civil Engineers Society, of St. Paul, and the Board of Water Commissioners, of St. Paul, jointly invite the President and Members of the Association of Water Works to spend Friday afternoon, (July 15th), in viewing the various points of interest about St. Paul and the City Water Works.

A committee from the Society and Water Board will arrange the details with you.

Respectfully,
GEO. L. WILSON,
Sec'y Civil Engineers Society.
JOHN CAULFIELD,
Sec'y Board Water Commissioners.

On motion the invitation was accepted.

The Secretary then read a paper entitled,

ORGANIC LIFE AND MATTER IN WATER.

BY SAMUEL MCELROY, C. E.

In responding to the request of this Association, to discuss in some formal way the subject of spongillia in pipes, I have felt that it would be more acceptable to my associates to treat a minor incident of organic life, under the head of "Organic Life and Matter in Water," so as to discuss the general relations existing between these and the water we drink.

I propose therefore to present some of the results of a long study of this question, as to the conditions, experiences, causes, effects and remedies of the evils produced by organic matter, which so seriously affect all our supplies of water in reservoirs and distribution systems.

DRINKING WATER; SOURCES.

That the human race, carrying about 65 to 75 per cent of water in their bodies, should find this constituent a very important one in daily use and maintenance, is natural: and that its quality should bear a very important relation to human comfort and health, is equally so.

When we study, ever so hurriedly the wonderful provisions by the Infallible Engineer of the universe, for our supply of water, the purity of its parent source, and the magnificent scale of the supply, we approach a subject of most absorbing interest.

We see this enormous globe of ours, a huge boiler, with its diurnal axis revolution, and about four-fifths of its area in ocean expanse, sweeping its annual orbit around an inexhaustable furnace, engaged in a process of circulation of currents, evaporation, condensation and rainfall, on the most regular, infallible and stupendous scale; and we see too, that the water thus furnished for our supply, is pure, distilled, and most thoroughly aerated in its passage over the continent as vapor, and its descent to the earth as rain; contamination comes from earthly contact. Its chemical constituents too, eight parts oxygen and one of hydrogen, by weight, with one oxygen to two hydrogen by volume, show the same guardianship of quality.

In its passage through the lower atmosphere, aided by reduced temperature and other conditions, rain water absorbs various acid gasses and takes up various forms of solid matter, so as to be somewhat impregnated with contaminations; but it is in its flow over the surface and through the underground formation of the earth, that its absorbent and solvent powers, subject it to the greatest contaminations. In the constant procession of all rainfall from the solid land to the ocean, for re-evaporation and return, by surface wash; by its absorption of carbonic acid and other solvents; by the aid of frost and heat; by abraision, solution and transportation; mechanically and chemically the various forms of solid matter in the air, on and under the earth's surface, are taken up and carried along with the entire water flow from higher to lower levels in an unending process.

To pause here and attempt to follow in the most cursory way, the laws, conditions, processes and results of this wonderful transportation by water, as solid, liquid, or gas; or in the atmosphere; the mountains, valleys, lakes and rivers; the busy underground springs; the great ocean currents; would occupy our time to the exclusion of the subject under discussion; yet it must all be studied and comprehended, before our subject can be fully understood.

Let us then assume certain facts of contamination exposure, as demonstrated, and examine some of the testimony as to the result.

This testimony comes from two expert witnesses, chemical and microscopic science; each has its special domain; what the

characteristics of each are, it is important for us, here, to examine, for very serious mistakes have been made for want of such examination.

Chemical analysis has been the professional rule of water examination until quite recently. Its processes in the laboratory are exceedingly delicate, and its results, as to various mineral constituents, solid or gaseous, are necessary, and implicitly accepted.

In our days of former practice the custom was, and is still, to send a chemist a sample of water taken in any convenient way from the stream intended to be used, or from the supply in use, and generally from the surface; samples were more or less disturbed in transportation, and allowed to stand some time before test; and the relative quantity tested, to the daily supply, was in very great disproportion. The water of a stream as affected by currents or winds and different depths or exposure to contamination, may vary seriously in the same body, as all experience shows. Relative motion, temperature, time for subsidence, or barometric pressure, may seriously affect some mineral and organic constituents of the sample, but these are not taken into account.

In an important series of tests made in Massachusetts, the samples after standing twelve to eighteen hours for subsidence, were decanted for test without the residuum. They were then passed through filter paper and treated for ammonia, albuminoid ammonia, and oxygen required to oxidize; the water was evaporated at 212°, the residiuum treated with aqueous solution of carbonic acid, and again dried at 212° and the loss on ignition tabulated as "organic and volatile." After a large expenditure of money and time, the commission failed to find any very unhealthy contamination in streams actually noxious to sight and smell, from factory discharge.

In this analysis the most modern processes were applied. Ammonia was determined by distillation with carbonate of soda and estimating by Nessler's reagent. Subsequent treatment with a strong alkaline solution of permanganate of potash, (Wanklyn process), liberates an additional amount of ammonia, as "albuminoids." Chlorine was determined in volume by nitrate of silver; Kubel's method; permanganate of potash, was used to determine "oxygen required to oxidise organic matter."

This system of collection, subsidence, evaporation and residuum has been the common process for a long time; yet it is well known that simple aeration rapidly reduces carbonic acid in water, and boiling, about one-half; that a temperature of 140° to 220° destroys organic life and disease germs; that some acids, like "boracic," may stand a white heat in a residuum, and yet escape sensibly in water solution; that ordinary solar evaporation liberates enormous weights of common salt, chloride of potassium, magnesia, &c.; and that organic matter in either healthy or diseased state is peculiarly sensitive to solution and boiling, which volatilises and expels gaseous and other constituents.

The criticism of chemists on the Wanklyn process is that "different organic substances disengage different amounts of ammonia," and the test for "albuminoid ammonia" is constant only for any one substance. Watt asserts that part of the loss by ignition of residuum may be due to water combined with calcic and magnesia chlorides or sulphate; and to volatilisation

of ammoniacal salt or decomposition of magnesia chloride, nitrites and nitrates; organic substance, when dried may partly decompose and some remain in a fixed state; and the errors nearly exceed the whole amount of organic substance.

Any study of chemical authorities makes it plain that our customary appeal to this branch of science, has been in some cases, a mistake. It is for this reason we find our city authorities so often baffled in their attempts to solve the problem of water fermentation, and obliged to content themselves with the oracular dictum, that science fails to detect the cause of the nauseous state of supply, and to accept the common anodyne prescribed, that there is nothing injurious to health in the process.

Microscopic science grasps the facts as they actually exist, and studies the processes of fermentation from beginning to end. It is comparatively a recent application. A great revolution in opinion and practice has come over the medical world within ten years. Before this it was difficult to find a doctor or medical authority disposed to discuss with any patience, the germ theory of disease. The elaborate researches of men like Pasteur and Dumas of the French academy, Lyndall, Bastian and others of the English school, and various German professors, were not accepted as demonstrations of a great law, and were publicly and formally excluded from adoptlon, as in the convention of 1876, at Philadelphia, but facts are stronger than theory or prejudices, and now it is difficult to find a medical doubter.

On land and sea then, for a few years past, the microscope has been busy in many hands, and with wonderful results. Voyages like those of the "Beagle", the "Challenger", the Coast Survey steamers, and the Fish Commission, have made us familiar with the deepest recesses of the ocean, and exploded more than one "intensely scientific" theory. Close studies of the air we breathe on the highest mountains covered with ice; in the deepest mines; in city streets; crowded rooms and hospitals, as in the open fields; tell us now where and how organic life and matter are found and in what abundance. Sewers and sewage, streams, reservoirs and distribution supplies are brought under the same infallible inspection, and give up their secrets of contamination. We have reached a point in all this, where the errors of the past can be comprehended, and the lessons of the present and future properly outlined.

DIFFUSION.

In ways past finding out to the chemist, the student in microscopic life has aided the naturalist in enumerating and classifying the organic life of the earth, and in proving its universal diffusion, especially as to the lower forms, with which our subject is most fully identified, but which we are still denied here any time for discussion in detail. The upper and lower currents of the air and sea; the channels of the earth's surface and depths, all have the same witness to bear, confirmed even by the revelations of our hardest minerals, like the whetstones, of the extraordinary present and past age abundance, and wide spread diffusion of forms, visible and invisible to common sight, of the teeming organic life of the world.

Where our text books talk about 15 feet as the limit of plant life, the dredge in Lake Erie brings up the "nostoc" from a depth of 430 feet; and in kindred animal life, the star fish are found along the telegraph cable lines, feeding on "globigerinoc" 2000 fathoms deep; and at all ocean depth, life abounds.

Any examination of a flowing stream or more quiet collection of water, as in ponds or reservoirs, shows a universal tendency to vegetable growth where the conditions of soil, or bed, and motion, are favorable. Botany classifies a large variety of water plants, partly or wholly submerged. There are weeds, grasses, sedge, star warts, al warts, penny warts, marsh plants, rushes, mosses, lilies, floating milfoil, chora, intella, &c., as aquatic plants, with the algæ, fungi, sphoqua and lichens of the cryptogams. In sea water live all the varieties of the marine plants, of algoid and other classes, in their different zones, and in profusion under favorable conditions of stationary or floating soil, temperature and food.

In like manner higher and lower forms of animal life abound in water under favorable conditions of existence, from the vertebrates, shell-fish, worms, star fish and others of higher classes, to the "root footed" animals, sponges, cilia feeding vorticella, monads, infusoria and bacteria of the lower forms in the scale.

In addition to this abundant organic life, plant and animal, it is also evident that the constant downward flow of water carries with it and into its receptacles more or less organic matter, diseased or dead, to provide food for all this life, and to continue its successive processes of dissolution where not assimilated as food. Many of our large reservoirs are formed in valleys covered with vegetable mould and vegetation, without any special or adequate care to remove it.

If we study the distribution service of any city in common use, we find that while the house taps, inserted in the top of the mains, carry clear water through the house services, even where considerable velocity is used, the mains generally contain more or less deposit of sediment, soil, oxides, and other solid matter, mineral and organic. The fire hydrant in full use, or the street blow-off, reveals, in the dull red color of the discharge, the presence of this sediment, part of which is produced by the chemical action of the water on the carbon and other constituents of the cast iron mains.

Whenever then this deposit furnishes a soil bed for the growth of spongillia or any other animal or vegetable form, the proper remedy is to sweep out the mains with appliances successfully used for that purpose, (we need not pause to describe here), which have been provided for the obstructions caused by tuberculation of our cast iron mains, itself a very serious evil.

A judicious and frequent use of the blow-off would doubtless tend to prevent much of this growth, partly by removal of its bed, and partly by bringing it in contact with oxides formed in the mains, and it is quite certain that this would also improve the quality of the supply.

Assuming then, that as to spongillia and like growths in our mains, the remedy is as plain as the evil. Let us examine briefly the evils which exist in our collections of water, as producing results of this and other kinds.

FERMENTATION AND PUTREFACTION; EXPERIENCE.

Since the microscope has demonstrated the universal presence of organic germs in the air, water and earth, and the law of development is simply that of proper soil, or bed, or lodgement, food, moisture and temperature, this life will spring into action whenever and wherever these favorable conditions exist; and since living, diseased or dead organic matter is liable to be produced, carried or accumulated in our bodies of water, the natural processes of life and death must ensue.

I have collated for many years the experience of city supplies and various bodies or streams of water, and find they all develope the same action to a greater or less degree from the underground currents, feeding certain wells, through creeks, rivers, and reservoirs, to the ocean itself. Whether we take the great centers of population where demand is most active, or the smallest village, we find that under favorable conditions this action is of common experience.

New York in the earliest examinations of the Croton, showed considerable volatile matter, (4.28 grains in 70,000), and carbonic acid (17.4 cub. inches), and various specimens of lower form life. In its early history considerable excitement is recorded on account of the occasional objectionable smell and taste, and the occasional contamination of the reservoirs has been a matter of unusual anxiety. In August, 1859, the papers were full of discussions on this account, and abundant instances cited of its injurious effects on health. Nevertheless an eminent chemist reported the cause "a rapid and abundant growth of a microscopic conferva" * * * "which I strongly suspect as derived from a species of the germs nostoc." (Rept. Croton Board, Aug. 27, 1859.)

In the Philadelphia supply the precautions taken about 1819 by Mr. Graff, an engineer of great skill, by a system of four reservoir surface decantations, enabled him to send such water as that of the Schuylkill, into the house services in a greatly improved state. But that the supply of this city has always been objectionable, is abundantly evident, and the necessity of a large expenditure for a better supply is fully recognized in recent reports.

Our Brooklyn supply of water, filtered on a vast scale, is sometimes unfit for drinking for two or three days, and the supply reservoirs sometimes show, at the gate houses, strong evidence of this action.

Though Chicago draws her supply from a tunnel projected two miles into Lake Michigan, complaints of the supply have been made, year by year, as they were before the tunnel construction made to obviate the trouble, which it has reduced. A much longer extension is now contemplated.

Cleveland, drawing its supply from Lake Erie by a tunnel extended in 1874 to about 6600 feet, to obviate similar experience, is at times suffering from various complaints.

At Boston the complaints of the Lake Cochituate supply are of long record, though exceeded by those as to Mystic Pond. In 1854 very elaborate examinations and reports were made, and much valuable information obtained as to the processes of fermentation, by such accomplished observers as Prof. Hosford. In that case the complaints became serious in the latter part of

September, and continue to some extent through January. It was found that the surface currents of the lake were pure, when the depths were foul; that the mains showed active lower forms of life, and dead organisms; that dead ends continued offensive when circulating supply was filtered; that in the several divisions of the lake the time of contamination and correction differed, as also in different depths; that instances of fatal effect on fish and other higher forms has been observed; and that separating one infected division from another less affected, would correct the latter in a short time.

Albany introduced the Patroon's creek supply, with storage reservoirs of shallow depth and large area, in 1852. The annual hot weather experience was very annoying, and culminated in 1875 with a recourse to the Hudson river by steam pumps, and the city is now contemplating a large expenditure for driven well supply from the sand plains west of the city. For about twenty-six years the annual reports abound in discussions on this subject.

Rochester, N. Y., is supplied from a large natural lake, by a pipe line of about twenty-eight miles with a fall of two hundred and sixty-one feet. The water springs into the air at Mount Hope reservoir, with a jet of about eighty feet and is thus aerated. In 1876, Prof. Lattimer made a careful investigation of the state of the supply, and in this and subsequent reports, collated a large amount of information on the experience of other cities. The fishy odor continued, in that case, for about three months, October, November and December.

It would be tedious to collate here the abundant examples of this action on record at Auburn, Baltimore, Burlington, Camden, Chickopee, Cincinnati, Hartford, Keene, Lynn, Meriden, New Britain, New Haven, Norfolk, Oswego, Poughkeepsie, Saratoga, Springfield, Trenton, Warsaw and Yonkers. In various creeks, rivers, ponds and lakes, in the ocean itself, this is a law more or less apparent, more or less active, and undoubtedly, to some extent, operating in all our usual collections of water.

That the effect of this process is a nauseous and noxious condition of the supply, is sometimes gravely denied by very scientific authority, but not by common sense people. As a rule, local patriotism keeps the record out of annual reports. In the proceedings of this Association for 1886, Mr. Keating, page 71, has catalogued truthfully the evidence furnished by taste and smell, the "fishy," "woody," "musty," "nauseous" odor produced; other observers at New York and elsewhere, have directly connected this state of the supply with stomach diseases; abundant evidence, of deadly effect at times, on higher forms of organic life, are on record, notably, a case off the Florida coast, among the live fish carried in the holds of the fishing smacks and other fish, produced by the state of the gulf water. That the trouble often originates at one point and the water affected is carried to others; that it appears suddenly at times, and disappears as suddenly; that it is most common in or just after hot weather, though not confined to the warm season; that impure water undergoing this process sinks from greater gravity, and thus illustrates one of the ancient engineer tests, *aqua levissimus;* that the mud beds of reservoirs as at Croton lake, and other cases, at times freely discharge bubbles of carbonic acid gas and

other gases, when disturbed ; that various microscopic and other animal and vegetable organisms abound in fermenting water ; that air, moisture, light and heat promote this action, which then goes on without air, but never without food ; are well established conditions.

Let us then examine the causes of this action on organic matter.

There appears to be several ways in which this matter, partially or wholly dead, is transformed into solids and gasses.

In a very dry atmosphere like that of Peru, for example, with heavy night dews, but no heavy rainfall, a dead animal slowly dries up without putrefaction, by *dessication*.

Where live, diseased or dead organisms are *assimilated* by higher forms, putrefaction is prevented.

Where the same matter is changed by the lower forms by a process analogous to assimilation, it is commonly called *fermentation*.

Where neither dessication, assimilation or fermentation take place, or do not act in sufficient force, the transformation into solids and gases is by the nauseous and noxious process of *putrefaction*.

There is also a process of exposure to air, light, and other agents, by which *oxidation* of organic matter is produced.

In this organic world there are constant life, disease, death and decay ; production, reproduction, food assimilation, illness, dissolution ; the plant world living on sustenance drawn from the earth and air ; the animal world fed, in addition, by plant life, and subordinate forms of its own life. These, in their order create and sustain, complicated chains of mutual dependence of absorbing interest to us all, we cannot pause to consider here.

On the organic matter then, found in our water supply, there are three of these processes at work, either in assimilation, fermentation or putrefaction. Let us examine the last two briefly.

Fermentation is a change, which takes place under the influence of common air, moisture, heat and lower organic life, in the constituent parts of either vegetable or animal substances ; it is indicated by sensible internal motion, the developement of heat and the evolution of gaseous products. It is divided according to the effects and substances acted on, into saccharine, acetic, alcoholic or vinous, lactic, butrycic, glyceric, mucous, and other results. Of these, some processes are completed without offensive odors, as the "acetic" and "vinous," nitrogen being absent.

The *germ* or *vital* theory which attributes the decomposition of the fermentable body to the vital action of living organisms, like that of the vegetable cells of the yeast fungus, is now generally accepted.

The office of the lower forms, in this action, is that of practical assimilation of the organic matter of a plant or animal. Its body furnishes the adult a lodgement and its germs a birth place, and the food necessary for development. It brings them from dorment germ life, into active existence, and not the reverse ; their presence is a consequence of the organic presence and not a cause, and their work is that of a sanitary police.

Putrefication, which results from an excess of organic matter, not assimilated or fermented, is the process by which

animal and vegetable azotised substances undergo decomposition with the production of offensive gases. The essential conditions are the presence of disease and dead matter, of moisture, of a temperature generally between 32° and 140°, exposure to the air before, or during the process; resulting in the formation of carbonic acid, sulphuretted, and phosphoretted hydrogen marsh gas, ammonia, nitrogen, hydrogen, various acids, and many offensive bodies not yet identified.

In the case then which we are studying, there is no escape from the conclusion that the presence of large bodies of organic matter in water, leaves only a question between its assimilation or putrefaction. Nature must act in one of these ways; the office of the lower forms is sanitary, if a sufficient sanitary police is produced; if not, the more offensive process must act, with effects destructive of the higher forms, and probably, at times to the lower.

REMEDIES.

It is evident then that the first duty of hydraulic engineers is to prevent the presence and the accumulation of organic matter and solution in water by attacking it first in the streams, conduits or other sources of supply entering our reservoirs, and at the reservoir outlet. Filtration, properly made, is a valuable, but not an infallible or permanent aid.

No evil exists without an ample corrective, if it is properly applied. The air and the soil abound in counteractives, tending to oxidise and destroy diseased and dead organic matter.

Natural oxidation of water by aeration is a valuable agent; at Philadelphia and other places, artificial aeration is found valuable. The Graff process of decanting purified surface water into reservoirs or conduits is another valuable method very much neglected throughout the country. Methods by which a supply can be impounded and fermented are important. I made a careful provision of this kind for the supply and distributing reservoirs of the Brooklyn works, which was not carried out as the contract required.

Appliances have recently been made by which the action of iron oxides, always a powerful agent on organic matter, can be directly applied to a conduit so as to effectually purify large bodies in motion. At Antwerp this was done in 1885, (Eng. News, Sept., 1885, 147), by the use of three revolving purifiers, which bring the water constantly in contact with particles of iron, to take up a sufficient quantity of oxide to produce the desired effect. In that case, treating 6,854,000 gallons, one-tenth grain per gallon was sufficient. To drive each cylinder, about 15 feet long, weighing in all 14 3-10 tons, with 2,464 pounds iron, at one revolution in three minutes, required four-tenths horse power, the capacity of the three being 15,000,000 gallons per week.

It is only necessary to indicate evil to be corrected to bring into successful action in this country the proper remedies. I have already taken up so much time on a subject long felt to be of vital importance, as not to feel at liberty or consider it necessary to extend this discussion at the present time.

Mr. G. E. Beach read a paper entitled:

SHOULD STORAGE RESERVOIRS BE OPEN OR CLOSED?

GENTLEMEN:—In endeavoring to treat upon this very important question, I find myself at the very outset, beset with difficulties and knotty problems far beyond the abilities of your humble servant to cope with. Although the title is short and comprehensive, still to enter into a complete digest of all the merits and demerits of both open and closed storage reservoirs, requires not only a very careful study of causes and effects, covering a long period of time, but a considerable knowledge of chemistry, in order to the more fully explain to the comprehension of others, the full nature of such causes and effects. We find that we have a large varied condition of circumstances to contend with, such as climate, capacity, quality of water, temperature, condition of atmosphere, material of which reservoir is constructed, and many other elements and conditions, making the subject one of too great a magnitude to attempt to cover by a single paper, before your honorable Association; however, I will endeavor to present for your consideration, such facts as are readily obtainable with my limited knowledge and ability. In order to avail myself somewhat of the knowledge and experience of others, several months since I sent out over 100 circulars to Water Works Officials, using reservoirs both open and closed, in the form of questions on this subject, as follows:

1. Name and address of your system.
2. Is your reservoir open or closed.
3. Capacity of reservoir in gallons.
4. How built, of earth, brick or stone.
5. Source of supply of water.
6. Quality of water before entering reservoir.
7. Quality of water after standing in reservoir.
8. How often do you find it necessary to clean out the reservoir.
9. What is the nature of matter taken out in cleaning.
10. Is reservoir troubled with frost, if so, to what extent.
11. Is water affected by action of sun, if so how can it be prevented.
12. Is water in reservoir affected at times with bad odor or taste, such as, fishy, woody, musty, nauseous, cucumber, vegetable or any other disagreeable odor or taste, if so, is it more discernable at one time of year than another, and what time does it occur, how can it be remedied or prevented, is water ever polluted by fungus or mossy growth, such as algae, &c., in what kind of water is this most likely to occur and how can it be prevented, please give any other information in your possession bearing upon this subject.

To which I have, at this date, June 28th, received several replies, many of which are answers in monosylables to questions asked, still quite a number are more lengthy and contain much valuable information. I allude to a few of these, bearing more directly on the subject as follows:

St. Louis, Mo.; open reservoir, sixty millions gallons capacity; built of earth, stone facing, walls in centre of embankment; source of supply, Mississippi River, has not been cleaned since built in 1871, about one foot of deposit; water not affected

by sun or atmosphere, no fungus or mossy growth, algae or other substance, no bad odor, taste or smell at any time.

Hannibal, Mo.; open reservoir, one and one-half millions gallons capacity, water good before being pumped to reservoir, better after standing, clean once a year, sediment, silt; not perceptibly affected by sun or atmosphere, no fungus or mossy growth, no bad taste or smell at any time.

Quincy, Ills.; open reservoir, twenty-two millions gallons capacity, built of earth, stone lining; source of supply, Mississippi River, not yet necessary to clean, in use five years; has a vegetable growth in summer, a hairy, filtrous moss, has a pronounced fishy taste in hot weather, but this does not seem to be due to anything in reservoir, as it is not apparent in water dipped up from reservoir, it is apparently due to some condition of the pipes, we have found it remedied largely by blowing off all the fire hydrants, and have concluded that the dead or bilgy water in the hydrant connections with the mains gave rise to it.

Muscatine, Iowa; reservoirs closed, capacity two millions gallons, built of earth, brick and cement; source of supply Mississippi River; clean out twice a year, sediment, river mud; no bad effects from sun or atmosphere, as after standing a week at a time water seems as good and pure as ever; reservoir 20 feet deep, sides 128 by 140, slopes 1½ to 1.

Wm. Molis, Supt. writes; in regard to bad taste or odor, we have never experienced any trouble in that way, the only trouble we have is a green scum, a vegetable growth of cryptogamous nature, full of animalcula which when exposed to the sun, out of water, gives forth a fetid odor. This growth never goes below the surface; always found on top, the growth is, or developes into the snail order, as found by experiment by letting them hatch out under a glass case, but then we have not found the first sign of them in our pipes, and on cleaning out reservoirs it disappears entirely. I think all reservoirs in this section of country are affected in the same way.

Savanna, Ills.; reservoir closed, built of stone and cement; capacity, eight hundred thousand gallons; source of supply Mississippi River, at times a little muddy and a slight swampy nature, after standing find water much improved. W. H. Griffith, Chairman Board of Water Commissioners, writes; at present, use of water about one million gallons per week, we find that cleaning out once a year is sufficient; sediment, a soft mud of a dark grey color; have had no trouble with frost whatever. As to the action and effect that sun has on water stored in large reservoirs, my experience has not been very large, still I think the heat of the sun does create a growth of green fungus matter. On a recent visit to St. Catharines, Ontario, where the Supt. is a relative of mine, I find that they are troubled with a heavy growth of moss, so that it was difficult to get a small boat through, although reservoir was thoroughly cleaned every season at great expense. My preventive would be to construct a reservoir such as we have here, cemented on inside and with a good roof; clean it out as often as necessary, and the trouble of fungus or mossy growth will be obviated.

Decorah, Iowa,; reservoir closed; capacity five hundred thousand gallons; stone cemented: source of supply, well; not cleaned since built in 1881. An analysis shows it to be the best water in the city, no bad taste, odor or fungus growth of any kind.

R. B. Tuttle, Chairman of Water Works Committee at time Works were built in 1881, writes; I am not a member of City Council at present, but believe that with open reservoirs the utmost care has to be taken to prevent the water from being contaminated by fungus matter that would be prejudical to the health of those using it. At Sioux City, Iowa, their reservoir is enclosed with a wire screen and in addition, a man employed by the year to guard it. Diphtheria prevailed to some extent, in Decorah, last winter, and an analysis of the water from the different sources of supply showed that the water taken from the reservoir was the purest that could be obtained. I wish I was more fully able to give you information on a matter of such great importance.

D. C. Fry, Supt. Water Works, Jacksonville, Ills., writes; our reservoirs are all open, the impounding reservoir holds eighty millions gallons, fed from surface water, springs and from tilled land; giving a description of the manner reservoirs are built; have cleaned reservoir every two years; sediment, mud, black dirt and fish; are not troubled with frost; water is affected in Distributing Reservoir a little by the sun in month of August, not affected with bad odor; We pump into distributing reservoir every day, which keeps it pure, if allowed to stand for a long time it would become stagnant.

Newport, Ky.; reservoir open; capacity forty millions gallons; source of supply, Ohio River; does not need cleaning, although in use 14 years. Since works have been in operation there have been but very few occasions when water was affected by bad odor or taste, in those instances, however, it was decidedly fishy; as consumption has increased and more frequent renewals of supply to the basins, the trouble has ceased, it is about 5 years since the last case, have never had any trouble, except in mild or warm weather.

Catskill, N. Y; reservoir open, capacity four and a half millions gallons; source of supply Hudson River. F. P. Smith, Sup't, writes: reservoir has not been cleaned since built in 1885, do not consider that action of sun has any effect on water; water has been affected once in each year since works were put in operation, with a fishy odor and an oily, nauseous taste, commencing about May 15th and disappearing in about two weeks; this spring the taste and smell came promptly on time, and I immediately had the mains thorougly flushed, the taste and smell continued only two days after; My opinion, however, is that the condition of the water is due to other cause than filthy water mains, but I am not at present prepared to give a decided opinion as to what the cause is.

Akron, O.; H. C. Star, Secy. and Treas. writes: I can answer some of your easy questions, but the hard ones I will let some one else wrestle with. Reservoir open, six millions gallons capacity; source of supply, lake and well, quality about the same as Lake Erie; we keep water in motion by pumping, still when water is low and sun shining, there will a substance grow and rise on the water, of a mossy growth or perhaps algae; two years ago we had a severe dose of fishy taste and smell and have had it mildly at various times since, as to the cause Doctors disagree.

Ithaca, N. Y.; J. L. Morris, of Cornell University, writes; reservoir open, capacity one million gallons; supply from Fall

Creek, clean out twice a year, water somewhat affected by sun, remedied by pumping in and opening overflow, sometimes a fishy taste in summer time, no moss, remedy open hydrants and blow off; four open reservoirs well fenced in, too expensive to cover them.

Lynn, Mass.; reservoir open, capacity twenty millions gallons; source of supply, small stream, cleaned once in 13 years. Daniel Walden, Supt. writes: after explaining impounding basins, our theory has been that the bad odor and taste came from the ponds being newly made, and our experience would seem to confirm that theory.

Ottumwa, Iowa; reservoir open, capacity two millions gallons; supply, river, cleaned once in five years; in regard to bad odor and taste, most of them are likely to occur in extreme hot and long drouths, the fishy taste we experienced once.

Cleveland, Ohio; reservoir open, capacity eighty millions gallons; supply, Lake Erie; twice in twenty years had the fishy taste, in month of July, found water in Lake similarly affected, was accompanied both times by rank growth of algae in reservoir and protracted period of still water in Lake.

Oswego, N. Y.; reservoir open, capacity seven and a half millions gallons: supply, Oswego River, with filters, clean reservoir once in two or three years; months of June, July and August sometimes gives a fishy or cucumber flavor, cannot be remedied except by expensive filtering and aeration; very little fungus or mossy growth of algae, &c., remedied by drawing off water, letting sun kill the growth, then clean it out.

Grand Rapids, Mich.; A. C. Sekell writes: reservoir open, capacity six millions gallons; had fishy taste in time past, but know of no careful studies relating to the cause; have about ten miles of wooden pipes in which are many fresh water sponges. My opinion is that storage reservoirs holding stream or surface water, may properly be left open when of large extent and having at least 20 feet depth, when the supply is ground or spring water, storage basins should be covered in as tightly as possible, to the exclusion of all light and air. This I think was the opinion of the late Prof. Nichols.

Paterson, N. J.; four reservoirs, open, capacity fifty millions gallons; supply Passaic River; when river is very low, water tastes fishy, river is fed by springs; pump each day what is consumed, and as water is constantly changing are never troubled with algae.

New Brunswick, N. J.; A. J. Jones writes: reservoir open, capacity fifteen millions gallons; description and drawing, showing how built; clean out once a year; source of supply Lawrence Brook, of good quality and soft, contains at certain seasons much vegetable matter in suspension, which we believe to be the principal cause of the unpleasant odor and taste occasionally noticed, and which has been the cause of much complaint in past seasons or until 1883, since which it has gradually improved; the taste was of the fishy, woody, cucumber variety of which you speak, and although at times coming as early as June, is not generally noticed until July or August. It is not noticable in the lake from which the water is drawn, nor was it noticed there when the water in reservoir was particularly objectionable, which led me to seek the cause between the lake and reservoir. After many fruitless efforts in other directions and some attempt to remove it or purify it with-

out filtering the water in the reservoir, I found by experiment that the water if kept quite under pressure for two or three days, when released would emit the odor complained of, while if kept in open vessels for the same period of time appeared to remain in good condition. We then stopped the pumps and left the water standing in the mains for from 48 to 72 hours, and as a rule it spoiled; since then we never (if possible to avoid it) permit the water to stand in the pumping mains longer than 12 hours, and have had scarcely any trouble although we sometimes get a trace of it. If our engines are not in operation for a day or two, which is frequently the case with us, we draw off all the water from the pumping mains before starting the pumps again. In the distributing and particularly where the circulation is not as perfect as it should be, we resort to the frequent blowing off at hydrants. Our reservoirs are kept entirely free from any vegetable growth I do not offer the foregoing as a solution of the difficulty by any means, but merely to give you the benefit of our investigations. I regret my inability to furnish you with more on the subject which might be of service to you in preparing what must certainly form an interesting paper.

Pierre, Dakota; J. W. Troy writes: Reservoir closed, capacity one million gallons, source of supply, settling well near Missouri river, quality of water pure and clear as it goes to reservoir; do not think it would be necessary to clean reservoir oftener than once in two years, as after pumping two years drew off water to clean it, but found nothing to clean out, five pails held all the sediment, which was fine sand carried through with the water from settling well. Water in well when not protected from sun, developes a fungus or mossy growth, but when protected from sun remains pure. This I have found by experimenting since the subject was discussed at Denver last year. Water in reservoir is not affected at any time with any disagreeable odor or taste, but if drawn off in vessels exposed to sun and air, it would assume a color resembling water that leather had been soaked in, and have odor like old rubber. I have made chemical tests of water here and find quite a per cent. of magnesia or chalk with slight trace of iron and very slight trace of organic matter.

Nashville, Tenn.; Geo. Reyer writes: Reservoir open, capacity two and a half millions gallons, source of supply Cumberland river, very muddy after heavy rains, clean out once a year, sediment 8 to 12 inches deep, water at its worst will settle clear and pure in 48 hours. Sediment composed of sand and clay; becomes offensive when exposed to sun and air; no bad taste or smell at any time and but little mossy growth and only in July and August when water is perfectly clear, have called attention of health officer to this growth, and he says it is not deleterious to health as it is the same as found on stones in pure streams. As to covering of reservoirs, it is my opinion that much depends on localities; if is distant from thickly populated districts and manufactories, I do not think it necessary to have them covered only in very cold climates; if however, they are located within or near manufactories, then it may be best to cover them. The affinity which water has for foul gases is readily shown by leaving an open vessel of water in a sleeping apartment where ventilation is poor, and after one night the water becomes very obnoxious. Chemistry informs us that strong traces of

ammonia are found in dew taken from grass at considerable distance from manufactories using bituminous coal, which contains considerable free ammonia, this being the case, it strikes me that with the great affinity which water has for this particular gas, that large bodies of water would absorb considerable, especially in places where a large amount of soft coal is used as fuel.

From a careful consideration of the foregoing reports and a personal knowledge of the facts connected with many other water works and reservoirs, we are led to the following conclusions, viz: That pure water, as taken from the earth, either from wells or springs, is by nature very productive of both animal and vegetable life, and that under favorable conditions these productions are spontaneous and without previous germination, still there are certain conditions required to spontaneously produce these growths. Some of the conditions required are as follows, viz: That the water itself must be practically pure, that it must be of a temperature of at least 50 degrees Fahrenheit, that it must be exposed to sun-light and air, that it must be without pressure or at least not to exceed 5 to 8 lbs. pressure per square inch, that it must be without contamination from sewage matter. As an illustration: Where reservoirs or basins are over 15 to 20 feet deep, algae is not known in the water, neither is it known in water polluted with sewerage, although the mossy growth may exist in water more polluted than that which would produce algae; as for instance, the water of the Mississippi river, which carries the sewerage of millions of people and domestic animals, is sufficiently polluted to prevent the growth of algae, still in some instances the mossy growth partially thrives, while the water is generally considered fair for domestic purposes. As to what algae is, whether vegetable or animal growth, it is not positively known, but of either class, it is evident that it is of the lowest order and produced spontaneously by the action of the sun upon pure water of no great depth. It appears to commence its growth in the early springtime, thriving till May or June, when it appears to mature and release its hold upon the bottoms and sides of reservoirs, rising to the surface and decaying in July and August, and producing the nauseous odor and taste so often alluded to. Since it would follow that the presence of algae in water is good evidence of its purity, and to a certain extent, the presence of the mossy growth alluded to, is also evidence of water comparatively pure, if the above theory is correct, the next question to be considered is how to prevent such growth in pure water. This can be done in several ways. First, have reservoirs deep; second, have them covered so as to exclude sun-light and air, which materially aids in keeping temperature at its lowest point, and again by admitting a sufficient amount of sewerage or filth to prevent its growth. It is no doubt a fact that many persons in charge of water works have declined to answer questions on this subject, where the water produced such offensive odor and taste, preferring that the public should be kept in ignorance of the fact if possible, rather than aid in solving an important problem.

On May 8th, last, the writer obtained from a small lake, known as Buell's Lake, near St. Peter, Minn., a quantity of the above described mossy growth and algae, and has since kept it in Mississippi River water, changing water occasionally. The

algae disappeared in a very few days, while the mossy growth partially thrives. The lake referred to, is of an area of a about 18 acres, with a varying depth of 2 to 8 feet. This lake is supposed to be fed by springs, having no visible inlet or outlet and having a water shed of less than 5 acres, the waters of which, from the dryest to the dampest seasons, have never been known to vary to exceed one foot. This mossy growth grew thickest on the side of lake from which the springs were supposed to be, and where the depth was least, none growing where water was more than six feet deep. Algae was only found near where the springs were supposed to be located. Samples of this mossy growth will be shown members of Convention: an analysis of the waters of above lake has been made, but not yet received, if received in time will also be submitted.

Now to the main question, should Storage Reservoirs be open or closed, it would appear that if water is taken from the ground, either from wells or springs, that it is very important that the reservoirs should be completely covered so as to exclude sunlight and heat, but well ventilated; while with water taken from rivers and lakes it is of much less importance, especially when stored in large bodies. Still where it can be practically done, it would no doubt be much better to exclude sunlight from all Storage Reservoirs.

THE PRESIDENT:—Mr. Denman, are you ready upon the subject of the legal relations of water companies and consumers?

MR. DENMAN:—I am ready. I fear we are getting almost too scientific for practical purposes. We have pretty thoroughly discussed the different mechanical appliances necessary to the supply of water, the various methods of purifying or filtering the same, all of which is not only interesting to water purveyors but necessary and beneficial. These things do not, however, comprise all that is necessary for the successful conduct of water works.

For it matters not that you have all these in perfection, engines and pumps of most improved pattern, pipes and pipe system the most comprehensive, water as pure as perfected chemistry can make it, but failing to understand your relations to the public, to make rules and regulations for the conduct of your affairs, such as shall stand the scrutiny of the courts and shall be just and equitable; to devise means not only for the gathering of your revenues, but also for the wise application of them; these things and more, to assume such attitude before the public as that every fair minded person shall be compelled to concede the justice of every demand you make and to pay your bills as debts honestly incurred; to fail in these is to fall short of that measure of success which ought to accrue to every well conducted business. I think, sir, that were a genuine effort made to instruct the public in their

due relations to the corporation which furnishes them water, that soon we would hear less and by and by no complaints at all of services rendered. I would take this occasion to impress upon our association the necessity and the good of learning first what are our rights before the law, and then of firmly but kindly practicing such things as are just and equitable, and such only.

I have here a book prepared by my son, the result of many months of labor by research in libraries and of correspondence, which embraces all the decisions of the courts in every State of the Union, of the United States Supreme Court, of the courts of England and her dependencies, concerning the rights of citizens with relation to water companies, I mean courts of final appeal. Of course I cannot read all that there is here, but must content myself for the present by reading a few words from the preface.

The book will be open to your inspection during the remaining days of the session. This digest embraces the decisions in reference to water supply of the courts of the United States, and of England and her dependencies. It is hoped that it will be found complete as to all cases found in the regular reports up to the year 1886. Where we had reason to suspect the completeness of the digests of the various sets of reports, the index of each volume has been separately examined. There is no text book or digest covering the whole ground occupied by this work. Angel on Watercourses, discusses fully and exhaustively the subject of springs, wells and subterranean waters. Dillon on Municipal Corporations, discusses fully the law regulating the relations which exist between water companies and cities. Williams' Prescriptive Rights, gives the run of the decisions regarding the right to use streams and other waters acquired by lapse of time. Coulson and Forbes on Waters, and Gould on Waters, particularly the former, have very many paragraphs of interest to water companies in various ways. Cooley on Taxation, discusses fully the subject of the taxation and exemptions of water companies, and the subject of assessments for water fixtures and improvements. Michæl and Wills' Digest of the Law of Gas and Water, gives a complete digest of all the English statutes and decisions in relation to this subject. The American and English Corporation Cases give all the late cases affecting water companies, and many valuable notes as well. Much of value in the way of notes has also been found in the American Reports and in the American Decisions. The Digest of Gas Decisions,

by Greenough, an American work, furnishes much that is valuable by way of analogy. But we have found no work or digest setting forth the American law of water works in a manner designed to meet the peculiar situations such companies often find themselves placed in. It is hoped that this work will prove a correct guide to all that has been decided in reference thereto.

The work embraces, among others, the following subjects: Property in Water; Nature of Water Companies; Water Companies and the Government; Duty of Water Companies to third parties not consumers; Consumers; Eminent Domain; Pollution of Waters; Municipal Water Works.

Upon the decisions herein contained the article which I now beg leave to present is mainly based.

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THE LEGAL RELATIONS EXISTING BETWEEN WATER COMPANIES AND CONSUMERS.

BY A. H. DENMAN, ATTORNEY, DES MOINES, IA.

Company compelled to furnish water to those who apply.—Water companies as they are generally, if not universally, organized, belong to the class of *quasi* public corporations. They are private companies to whom the State has delegated certain of its powers for the purpose of enabling them to do a public work. The State grants the franchise for the benefit of its citizens, and such companies cannot, therefore, refuse to supply all who were intended to be benefitted by that franchise. A water company stands in some sense in the position of a public officer authorized to administer to a certain public necessity, and is not privileged to make exceptions to the general provisions of the law which gives it its power. It is for such companies to yield their facilities to all who conform to certain conditions and come within the intention of the statute, and for a higher power to determine who shall be the objects of that bounty. It is difficult to conceive of a work which comes more legitimately within the province of the Legislature or of municipalities than that of bringing a supply of water within reach of all or as many as possible of the inhabitants, and of affording facilities in the way of reservoirs, water mains, etc., of which every one, by complying with reasonable requirements, may avail himself. But it would not probably be held that the State alone can traffic in water to the exclusion of individuals. If the State should undertake to forbid anyone from buying and selling water except those whom it might permit, or to whom it might give the exclusive right, it would indeed create a monopoly in the plainest sense of the term. But the State has certain powers which are peculiarly her own, and which she can delegate or not, as she sees fit. These things are not the legitimate subjects of private enterprise, and the

delegation of these powers by the State to one or more parties to the exclusion of others is not obnoxious, as establishing a monopoly. Therefore, while the State may not, perhaps, forbid traffic in water by private individuals, it lies entirely with her to say whether one or more such persons, to the exclusion of all others, shall use the streets for the laying of water mains, or condemn private property for the carrying on of their work, or who it shall contract with for the supplying of public buildings, sprinkling streets, etc. So whether or not a water company can be considered as a *quasi* public corporation, and therefore bound to supply all who reasonably apply to it, depends upon the fact of its acting in any sense for the State. To this end it is pertinent to inquire whether the State has delegated any of its powers to the company, or given it any exclusive privileges in the use of its streets, etc., or given it the right to condemn private property, or in any other manifested the intention that the company should act for the State in supplying the public necessities.

In regard to gas companies it has been held that to be a public corporation, and liable as such, the company must have more than a mere license or permission, not exclusive, to lay its mains in the streets, nor would the additional fact that the company is the sole manufacturer of gas in a certain neighborhood, bind it to furnish gas to any or all persons longer than its convenience or caprice might induce it to do so. (1)

Consumers Must Comply with Reasonable Requirements.—If the company is bound to furnish water to all who apply, it follows as a matter of course that it must do so upon reasonable terms. All rules and exactions on the part of the company which tend to deprive one of the privileges contemplated by the incorporation of the company are, as far as they go, violations of the principle which has just been discussed. The company can no more insist upon an unreasonable exaction than it can unreasonably and capriciously refuse water to one who applies. The former differs from the latter only in degree and not in kind. On the other hand, the right to draw water from the pipes of a water company is property and is not to be demanded as an unfettered right. (2)

There is a corresponding duty on the part of the consumer to comply with all reasonable conditions—he must make demand on the company for water; he may be required to do so formally by coming in person to the office of the company and there signing a written or printed application, which shall embody the contract between him and the company and bind him to submit to reasonable conditions imposed by the company; he may be required to pay in advance and to make a reasonable deposit to secure the prepayment of the rate for the future; to answer correctly questions concerning the probable number of rooms, size of premises, number of stops etc.; (3) he must provide himself

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(*1*) *Hoddesdon Gas etc. Co. vs Haselwood, 6, Com. B. N. S. 239; Patterson Gas etc. Co. vs. Brady, 27 N. J. Law, 245.*

(*2*). *Philadelphia vs. Cook, 30 Pa. St. 56.* (*61*)

(*3*). *Williams vs. Gas Co. 4 Am. & E. Corporation Cases 66.* (*See reporter's notes*). *Shepard vs. Milwaukee Gas Co., 15 Wis. 318. For a series of regulations held to be unreasonable, see Shepard vs. Milwaukee Gas Co., 6 Wis. 539.*

with proper plumbing and make it safe and free from leaks, (1) or else the company will have the right to refuse the demand. Many other regulations growing out of the necessities of the case or the peculiar relations subsisting between the parties, will doubtless be upheld by the courts.

Where one makes his own private and suitable connections, he is entitled to receive water through them and connot be compelled by the company to take through other fixtures and share the expense in common with other persons. Thus, where one occupies apartments in a "model lodging house," which is a building divided into distinct compartments for each family, and such person has his own separate and appropriate connections for supplying his own needs, the company has no right to insist on supplying the whole building through one system of pipes and compel such person to take water and share the expense thereof in common with the other occupants of the house, any more than it could compel the occupants of a block of houses to take water in this way. (2).

The company may refuse to supply a person already indebted to it or who refuses to pay the rate. (3.) The contract between the consumer and the company is a personal one and the occupant of a house connot be charged with the water rate defaulted by a former occupant of the same house. (4.) So, also, where the tenant defaults his water rate and the landlord afterwards moves into the same premises, the company cannot refuse to supply the landlord because of the tenant's default. (5)

The consumer cannot compel the company to supply him with water as for a family purpose when he has provided his home with the fixtures of a much larger establishment. The fixtures must be adapted to the demands made upon the company. (6). The company may refuse to supply one until he does away with all fixtures except such as belong to the class of consumers among which he intends to be classed. For instance,

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(*1*). *Shepard vs. Milwaukee Gas Co., 6 Wis. 539; Sheffield Water Co. vs. Wilkinson, 4 L. R. C. P. D. 410.*

(*2*). *Young vs. Boston, 104 Mass. 95. The "Model Lodging House" in this case consisted of ten suits of apartments or tenements, each one of which contained a sleeping room, kitchen and water closet and all the conveniences of a common dwelling house. There were no fixtures in the house used in common by the tenants, and no mechanical difficulty in the way of making separate connections or of attaching a meter to ascertain the amount of water used in each apartment. The apartments were not owned by tenants, but the whole building was owned and controled by a corporation which had general charge of the building and control of the outer doors and halls. An ordinance of the city of Boston also made special provision for such tenements where they had separate water fixtures.*

(*3*). *Note 4 Am. & E. Corp. Cases 70. People vs. M. G. Lt. Co. 45 Barb. 136.*

(*4*). *Sheffield Water Co. vs. Wilkinson, 4 L. R. C. P. D. 410.*

(*5*). *Dayton vs. Quigley 29 N. J. Eq. 77; Dillon Mun. Corp. 320.*

(*6.*) *Sheffield W. Co. vs. Carter, 8 Q. B. D. 832.*

where one contracts for water for family uses, which the statute makes to include movable but not stationary bath tubs, the company may refuse to turn on the water until the consumer disconnects entirely the inlet pipes to his stationary tubs, but the company cannot refuse because the consumer will not disconnect his out-let pipes as well. (1). Where the company is allowed to furnish water for family purposes at one rate and water for all other purposes at another rate, it has a right to insist that the consumer make separate connections and attach a meter so that the company may ascertain how much water is used for other purposes than for the family.

As to whose duty it is to pay for the meter will be considered presently.

Although the company has an undoubted right to cut off the supply of a consumer because of non-payment of the rate where the consumer does not dispute the amount due, yet the company is not thereby made the sole judge of the amount due to itself. If the amount due is in dispute, the company may be enjoined from cutting off the water until the question is adjudicated, and it would seem from this that the courts would refuse to order the water turned on again after it had once been turned off by the company, until after the consumer can show just as conclusively that the claim the company has against him is baseless. (2). Nor can a meter be taken as conclusive of the amount due to the company, although approved, tested by arbitration according to statute and found to work correctly.

In the case of Sickels vs. Manhattan Gas Company (3) an injunction was issued against the company, forbidding it from cutting off the gas from the house of S. On hearing of a motion to dissolve the injunction, testimony was, that S. on going to Europe with his family, turned off the gas from his meter and pipes by a stop-cock in the cellar and within reach of any one in the house. The servants testified, and there was no direct attempt to impeach their testimony, that the gas continued turned off during the entire absence of S. and his family. But the meter indicated that a considerable quantity of gas had been consumed meanwhile. The meter was admitted to be in good condition, and the company introduced testimony showing the impossibility of the meter's registering anything unless gas passed through it. The court held, however, that the above testimony was sufficient to cast a doubt upon the correctness of the meter, and refused to disturb the injunction until the question as to how much was due from S. to the company, was settled by a judgment at law.

In harmony with the principle of the case of Sickles vs. Gas Company, it has been held in Maryland that if a consumer owns two houses, and pays the price of the water consumed in one, but disputes his bill as to the other, the company will be enjoined from cutting off the water from the house paid for until the amount of indebtedness in dispute has been adjudicated. (4) It would seem to follow from this that if one owned

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(*1*). *Sheffield W. Co. vs. Carter, supra.*

(*2*). *Sickels vs. Manhattan Gas Co., 64 How. Pr. 334.*

(*3*). *Sickels vs. Manhattan Gas Co., 66 How. Pr. 31.*

(*4*.) *Gas Light Co. vs. Colliday, Shepard vs. Milwaukee Gas Co., supra, Sheffield Water Co. vs. Wilkinson, 4 L. R C. P. D. 110.*

several houses the company may refuse to furnish water to any of them until the consumer satisfies his indebtedness as to all, it being admitted that he owed a debt to the company on any one of them. So also it would seem that if one became indebted to the company at one place and moved to another, the company may refuse to furnish the water until the first debt is discharged.

Measure of damages for refusal of water and for cutting off the same.—In Gas Light Co. vs. Colliday, 25 Md., 1, it is held that to unlawfully break the pipe of a consumer connecting with a gas main is a trespass for which damages are recoverable, and the measure thereof is the deterioration in the value of the premises for sale or rental, and the cost of removing the fixtures and restoring the premises to their former condition. In Shepard vs. Milwaukee Gas Co., 15 Wis., 318, where gas was wrongfully denied to a store, the plaintiff was allowed to recover for the damage done to his business which could be actually traced to this cause, and also an allowance for the inconvenience and annoyance. The rule cannot be different for water companies, and may be briefly stated to be all the cost of restoring the premises to their former condition and allowance for all other losses in rents, profits and disturbance of the enjoyment, which are directly traceable to the trespass. In order, however, to claim damages the consumer must place himself in a right relation to the company, by making suitable connections and tender of the rate. (1).

Where tender has, however, been once refused the consumer need not repeat the tender every month, or whenever his bill usually falls due. He has a right to presume that the tender is refused until the company notifies him to the contrary. (2).

Obligation and Liability of the Water Company in Case of Conflagration.—In the absence of express contract, a water company cannot be held liable in damages for the destruction of the premises of a consumer by a fire, which might have been quenched had the water been furnished, even though the company was at fault in not keeping up the supply. (3). Not only so but the company may altogether refuse, in the absence of a contract, to furnish water for extinguishing a fire, although that may have been one of the objects of its incorporation. (4). If the consumer appropriates for that purpose the water of the company, which he has at hand, it is doubtful if the company could recover its value. If the company contracts to keep up a supply of water in the pipes at a certain pressure, with a view to quenching fires, it would, probably, under a familiar rule of the law of damages, be held liable at the suit of *the other contracting party, who has been damaged*, for all injury which could be clearly traced to the failure of the company to keep up the supply of water, according to its contract.

(*1.*) *Gas Light Co. vs. Colliday, Shepard vs. Milwaukee Gas Co., supra, Sheffield Water Co. vs. Wilkinson, 4 L. R. C. P. D. 110.*

(*2*). *Shepard us. Milwaukee Gas Co., 15 Wis. 318.*

(*3*). *Nickerson vs. Bridgeport Hydraulic Co. 46 Conn. 24; Atkinson vs. Newcastle & Gateshead Water Co. 46 L. J. C. P. 775; Blakeslee vs. St. John Water Co. 1 Allen (New Brunswick) 639; Campbell vs. East London Water Co. 26 L. T. N. S. 475.*

(*4*). *Nickerson vs. Bridgeport Hydraulic Co. 46 Conn. 24.*

When a municipality establishes reservoirs, hydrants, etc., of its own to provide against the spread of conflagration, it is not liable if the means provided are inadequate to the demand, which may be made upon them. (1). The responsibility of a city for the precautions which it takes, to prevent public calamities, is political and not legal. No amount of neglect, on the part of the city, to avert these things will render the city liable. Where a city suffers its hydrants, reservoirs and mains, built as a precaution against a conflagration, to fall into such a state of neglect and decay as to be useless, no action at law will lie for the damages caused by a fire which raged unchecked, in consequence. (2). Such cases are very different from the case of damage caused by defective sidewalks, or the bursting of a carelessly constructed reservoir, which would give rise to actions of tort against the city. The fact that a private water company is under contract with the city to furnish water, for the extinguishing of fires, gives the private consumer no more hold upon the company. In such case the company is not liable to the consumer, because there is no privity of contract, nor to the city, because the city has suffered no damage. The company can be held responsible only under its contract or to answer to the statutory penalty, if there is one, for failure to keep up the requisite pressure and supply of water in the pipes. (3).

Apportionment of Charges for Water Furnished by Companies or by the City.—There is no distinction in the law regarding charges for water between those made by private companies and those made by the city. As far as the private consumer is concerned both stand in the same relation. The power to collect charges for water consumed is a necessary incident of the power to furnish the water. The Legislature has the same power to regulate the charges of a water company as it has to regulate those of any other public corporation. In California, however, when the former constitution required all corporations not municipal to be formed under general laws, it was held that the fixing of the rates of a water company was a franchise, and not being a general law applicable to all corporations, was void under the constitutional provision. (4.) The law regulating charges for water turns upon the law of sales. The courts all proceed consistently with the proposition that the water is a commodity which is bought and sold. It is the law of personal property and not of realty which applies. Water rents are not taxes, although the statute may in some cases give them some of the incidents of taxes, as for instance, by making them a lien upon the premises and enforcing collection as the collection of taxes is enforced. (5.) We have already seen that the contract

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(*1*). *Tainter vs. City of Worcester, 123 Mass. 311; Black vs. City Columbia, 19 South Car. 412; Van Horn vs. Des Moines, 63 Ia. 447; Brinkmeyer vs. City Evansville, 29 Ind. 187.*

(*2*). *Grant vs. City Erie 69 Pa. St. 420; Patch vs. City Covington, 17 B. Mon. 722.*

(*3*). *Blakslee vs. St. John Water Co. 1 Allen (New Brunswick) 639; Atkinson vs. New Castle & Gateshead Water Co. 46 L. J. C. P. 775.*

(*4*). *People vs. Stephens, 62 Cal., 209.*

(*5*). *Aumann vs. Black, 15 W. Va., 773; Jones vs. Water Commissioner, 34 Mich., 273.*

of the consumer is a purely personal one except as the statute makes exceptions. Water rates being a charge for value received, the charge cannot be made until the company is prepared to furnish the water, (1) and where the supply is not so good nor so abundant as the company's contract calls for, the company may, nevertheless, recover a *quantum meruit* for what it has actually delivered. (2.) Back water rents may also be collected as for value had and received. (3).

The courts will sustain any reasonable charge based upon any fair method of estimating the quantity of water used by the consumer, but where no water is had no charge can be made Hence a town cannot impose a tax for water upon persons inhabiting premises not supplied with water fixtures and who do not take the water the town has to offer. (4.) Nor can a water rate be assessed against vacant lots, (5) nor can a building, the lower part of which is used as a store, be charged as an occupied house, or as a place where people are living and presumably requiring more water, (6) nor can a house used as a lodging house merely be charged for water as a hotel, more especially when the water does not rise therein further than the first floor, (7) all of which is upon the supposition that the rate paid is for a commodity and not for a mere privilege, nor for the use or rent of something, nor as a tax. The above instances are, of course, to be carefully distinguished from general taxes levied to pay for water used by the city itself, and from assessments against property for the laying of water mains, &c., in streets and highways.

Discriminations in Charges for Water.—Aside from meters (which we shall consider presently by themselves), and other means of actually measuring the quantity of water consumed, various ways of estimating the probable quantity of water used are recognized and upheld by the courts and are in common use everywhere. The charge for water may be based upon the use to which the premises are put, upon the number and size of rooms, number of persons occupying the premises, the number and size of the taps, area of the grounds and other considerations which really tend to affect the quantity of water used. The different uses to which the water may be put upon the same premises may also be made a basis of discrimination. One may for instance be charged so much for the use of water for his domestic purposes and another rate for hose, garden, stable or stationary bath purposes. Where such discriminations are used, the charges must be consistent—domestic uses cannot be assessed as something else which cannot be so included in the fair acceptation of the term.

Domestic Purposes.—Inasmuch as the quantity of water used for domestic purposes is seldom accurately gauged, but

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(1). *Ex parte Dallimore 11 Low. Can., 436.*
(2). *Failes vs. LeMaire, 13 Low. Can., 335.*
(3). *Girard Life Ins. Co. vs. Philadelphia, 88 Pa. St., 393; See also Clunes W. Co. vs. Winchester, 1. Victorean Law, 298.*
(4). *Allentown vs. Kramer, 73 Pa. St., 406.*
(5). *Provident Inst. for Savings vs. Allen, 37 N. J. Eq., 36.*
(6). *Shaw vs. Quebec, 16 Low. Can. 541.*
(7). *Cromwell vs. Stephens, 3 Abb. Pr. N. S., 26.*

based upon a rough estimate, and as this distinction from all other uses is so universal, it becomes important to determine just what such uses include. Domestic purposes include cooking, drinking, washing of clothes, persons and premises *of a family* —in short, water as applied to the usual and ordinary conduct of family life. (1). Hose and the use of water for gardens are usually excepted by statutes, ordinances or rules regulating the charge from domestic uses and would not probably, in any event, be construed to be such, nor can one, as we have already seen, draw a supply of water for family uses when he insists on maintaining fixtures calculated for the use of a larger establishment. The inhabitants of a work-house or penitentiary are to be supplied as a large family, for although the purpose of such a building is public, the water supplied for the life and comfort of the inhabitants thereof is supplied for a family purpose. (2). Not so, however, with a city hall or court house. (3). While purposes connected with personal cleanliness are clearly included in domestic uses, this does not include stationary baths in a private house. (4.) This would seem to include stationary wash tubs as well, although one who pays the charge for domestic purposes is thereby clearly entitled to all the water necessary for the washing of persons and clothing in other than stationary tubs. Where one is supplied with stationary tubs but removes his inlet pipes the company can then no longer refuse him, although he removes neither the tub nor the outlet pipe. (5). Stationary tubs are extra-domestic more because of the facilities they give for the drawing of water than for their character of bath or wash tubs. A private stable in which there were no water fixtures has been held to be included in a charge for domestic purposes. (6).

In England it is common to assess the amount of water used by families according to the income of the premises. The charge may be assessed proportionately according to the rent the premises command, or according to the rate at which the premises are assessed for taxes, or upon the actual amount or annual value upon which the assessment to the poor's rate is computed in the parish or district. When the rate is based upon the "annual rent" this does not mean the same as the "annual value" of the premises. (7.) The annual rent is to be determined by deducting the taxes or rates which the landlord pays to the government from the gross rent. When the houses are rented by the week and the water rent is assessed upon the annual rental, an estimated sum must also be deducted from the

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(1). *Weaver vs. Corporation of Cardiff, 48 L. T. N. S. 906.*

(2). *Liskeard Union es. Liskeard Water Co., 7 Q. B. D., 505; Spring Valley Water Co. vs. San Francisco, 51 Cal., 111; Hawes vs. Contra Costa W. Co., 5 Sawyer, (U. S. C. C.) 288; San Diego W. Co. vs. San Diego. 59 Cal., 517; Spring Valley Water Co. vs. San Francisco, 61 Cal., 18.*

(3). *Commercial Bank vs. New Orleans, 17 La. An. R., 190.*

(4). *Sheffield Water Co. vs. Carter, 8 Q. B. D., 832.*

(5). *Sheffield Water Co. vs. Carter, supra.*

(6). *Busby vs. Chesterfield Water & Gas Lt. Co., El. Bl. and El. 176.*

(7). *Sheffield Water Co. vs. Bennett, 8 L. R. Ex. 196, affirming S. C. 7 L. R. Ex. 409.*

gross rent, sometimes called the "annual value," to allow for times when the premises stood idle, but the landlord or whoever pays for the water is not entitled to an allowance for repairs or for insurance. (1). Value and "net value" are held to mean the same thing. "Gross value" is not value at all, but simply an incorrect expression like "gross profits." (2). Where the charge for water is based upon the "actual amount of rent," the company is entitled to assess the water rate upon a percentage of the net rent which comes to the landlord free of taxes and all expenses usual to keep the premises in a state to command such rent. (3).

Meters.—There can be no doubt that a water company or board, acting under general powers, has the right to assess the quantity of water used, at so much a gallon or one hundred gallons by actual measurement, and they have power to adopt any suitable means of measuring the quantity of water consumed, whether by meter or any other automatic arrangement that they see fit to adopt. In the case of Young against Boston, 1 Allen 361, a hotel which had been paying an estimated rate was metered, and found to consume ten thousand gallons of water per day, for which the court held that it must pay a rate of two cents per one hundred gallons as assessed, although the aggregate was four times the amount paid for the hotel, under the former arrangement, and but very few of the hotels in Boston were metered. But it is very doubtful, in the absence of statutory provisions, whether the company can compel a consumer to put in a meter at his own expense, or compel him to pay a meter rent. In Sheffield Water Company vs. Carter, 8 Q. B. D. 832, it was decided that the power to compel a consumer to rent or to purchase his own metre, could not be implied from a clause in a statute permitting the company to let metres for hire, nor could the company which was empowered to lay water pipes and "other apparatus," put in the meter and charge it up as a part of the "other apparatus".

In New Jersey it has also been held that while a water board acting under general powers have an undoubted right to assess a consumer according to meter, the board has no right to make him pay for the meter, nor for the rent thereof. (4.) In Sheffield Water Company vs. Bingham, 52 L. J. Ch. D. 624, the question came up in this form: Who must measure the water consumed—the company or the consumer? It was there decided that the sale of water as usually carried on, differed from usual sales of merchandise, in that the goods were not delivered to the consumer as he called for them, but it was put in his power to draw what he needed without the knowledge of the seller. Hence, it being solely in the power of the consumer to know how much water he takes, he is the one who is bound to know and to measure what that quantity is and to account for it to the company. Although it was held that the company might not have the power to prescribe any particular form of meter or measure

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(*1*). *Smith vs. Mayor, etc. 11 Q. B. D. 195.*
(*2*). *Dobbs vs. Grand Junction Water Co., 53 L. J. Q. B. 50.*
(*3*). *Dobbs vs. Grand Junction Water Co., supra.*
(*4*). *State vs. Jersey City, 2 Am. & E. Corp. C. 233 : see also Shepard vs. Milwaukee Gas Co. 6 Wis. 539.*

which the consumer must use, yet the consumer is bound to provide himself with some automatic arrangement which will accurately measure the quantity of water that he takes from the pipes. In this case, the defendant, who paid extra for a stationary bath tub, determined by actual hand measure the amount required for a bath. He then drew a line around his tub to indicate how far that quantity of water would rise therein. The family were forbidden to fill the tub above the line and were ordered to mark upon a calendar suspended in the bath room each time the bath was used. This arrangement the court found to be neither adequate nor just to the company, and that the defendant must use some automatic means which would accurately register the amount of water used and not to put the company at the mercy of the forgetfulness or the deceit of any one who might form part of the consumer's household. The reader can hardly regard the above cases as settling very satisfactorily the question who shall pay for the meter. The rule, if any, fairly to be deducted from the weight of authority above discussed, would seem to be, that the party desiring to measure the water must furnish his own means to do so, whether he be the consumer or the purveyor. The question, however, can hardly be regarded as settled. As the population becomes more dense these relations will become better defined. The practical difficulty with water companies furnishing meters to their small consumers lies in the fact of the usual cheapness of the water and the expensiveness of the meter. And yet the enormous waste caused by large numbers of small consumers is often a very serious matter and very hard to regulate, indeed as the matter now stands, it is to a degree impossible for the purveyor to enforce the care and responsibility he has a right to demand from the consumer. This would be almost wholly obviated by the use of meters. Then, in that case, if the consumer neglected his plumbing or his faucets, appropriated the water to uses he is not charged with, or allowed his neighbors, who are not consumers, to steal from his pipes, his own wrongs would come upon his own head. It would seem to be but reasonable that as the consumer is compelled to make suitable connections adapted to his demand upon the company, that some form of automatic measure should be included as a part of the necessary plumbing arrangements of the house. The company, it would seem, ought not to be compelled to furnish such fixtures to the innumerable connections which are made with their mains or else be left to so large an extent at the mercy of the fraud, deceit and neglect of tenants. The company ought not be compelled to furnish the meters any more than many other items of plumbing it has a right to demand that the consumer shall be supplied with.

If the consumer is not satisfied with the charge made against him as being in excess of the legal rate, there is some intimation in Young vs. Boston *supra*, that he may ascertain the true amount due from him by meter and tender the proper charge according to the water actually consumed. There seems to be nothing to prevent the consumer's attaching his own meter or other approved means of ascertaining what he actually takes and making tender in accordance therewith. This, however, does not apply to one already under contract with the company or city and who has agreed to pay for what he has a *right* to take. He cannot then come and compel the

company to accept the smaller rate because he did not use enough to justify the amount he has agreed to pay. But it would seem, reasoning from principles already laid down by the courts, that the company cannot compel a person to enter into a contract compelling him to pay for more water than he intends to use, and that the consumer is justified in tendering a sum which shall be a fair charge for what he actually takes, and shall fully compensate the company for all the labor and expense of supplying him. The company have, as we have seen, an undoubted and an unqualified right to attach its own meters and insist in apportioning the charge at so much per cubic foot, barrel or one hundred gallons, or any other suitable unit of measure it chooses to adopt. The courts have not gone very far in deciding these questions. Farther unfolding and application of the law to these matters may be confidently expected from different sources in the near future as the need increases that these relations be more strictly defined.

Upon conclusion of this paper by Mr. Denman, the meeting was on motion adjourned to accept the invitation to visit Minnehaha Falls.

Morning Session, Friday, July 15th, 1887.

Meeting called to order at 10 o'clock by the President, who said:

Our early adjournment yesterday cut off discussion on the most interesting paper by Mr. Denman, and as he has another of similar import upon the topic, "Is Water Property?" I will now call upon him to read it.

Mr. Denman:—God made the world. He made the minerals, the birds of the air, the fish of the sea, the water of the ocean, the streams which flow into it and the percolating water which supplies them—all in a continual round. He gave us the rain which, though laden with impurities, is by nature's process made pure and harmless. He does not look with approval upon still water (nor other product of the still) but keeps it moving constantly that it may be fit for man's use. Holy Writ is full of illustrations taken from water and its uses. Abraham, Isaac and Jacob, fathers of the covenant, dug wells and possessed them, and Isaac might well be considered by water purveyors as an ensample of patience under adversity, who though driven from one well to another by his enemies, yet so maintained his control that he at last succeeded in acquiring rights which even his enemies respected. The Red Sea and the Jordan

were divided and stood back, and the waters of the stormy lake were stilled at the voice of one who by right commanded them, and by the same commanding presence which at Bethany turned the water into wine which makes glad the heart of man. We read of rivers of pure water, clear as crystal, and of fountains of water given freely. What more intense figure can there be than that of a drop of water refused to quench the parched tongue of one who cries in his agony for such a boon. How different that from the blessing to him who shall in Christ's name give even a cup of cold water to him who is athirst. He sendeth his rain upon the just and the unjust. His rain falls upon the land and causeth the tender grass to spring forth. Job inquires, "Hath the rain a father?" for he draweth up the drops of water which distil in rain from his vapor, which the skies pour down and drop upon man more abundantly." "Drink waters out of thine own cistern and running waters out of thine own well," says Solomon. "He hath measured waters in the hollow of his hand," says Isaiah. "Waters on the left, waters to the right, waters to the ankles, to the knees, waters to swim in," says Ezekiel. It will be easily seen that if ownership exists at all, title must be derived from God the giver of all good and perfect gifts. God who gave the light, air, manna, the waters from the rock which followed the children of Israel through their wearisome forty years' pilgrimage, simply required that his children should appropriate to the extent of their needs, not to waste but to use, as upon an occasion he commanded that the fragments be gathered and naught wasted.

Having thus hinted as to where man derives his title, we make this proposition, that to appropriate unappropriated things is to acquire property right and to own the same by a good and sufficient title. We are again aided in the proper conception of this right of appropriation by Holy Writ, which is in fact the oldest authority upon the subject as is freely conceded by Blackstone and other commentators, to be the root and basis of all our knowledge upon the subject of the rights of man in property as well as the rule of conduct between man and his neighbor. Isaiah says, "With joy shall ye draw water out of the wells," and "I will pour water upon him that is thirsty." Jesus said to the woman at the well, "If thou knewest the gift of God * * * * thou wouldst have asked of him and he would have given thee living water," thus confirming our right to water by appropriation, as also to every gift and grace. Therefore, you may hold out your hand and

catch the drops in your open palm as they fall from heaven and call them yours. You may dig or bore the deep artesian and the product shall be yours from whencesoever it comes. You may store the frozen pond that it may, when summer comes, cool the fevered brow, the parched throat, or quench the thirst.

But we are to inquire more particularly into the rights of man by man's law, from whatsoever source he derives his notions as to ownership of water. To set out briefly this subject, I have been compelled by pre-occupation and by physical frailty to call to my assistance another hand who, in style, much better doubtless than my own, has prepared for you a commentary based on an examination of the decisions of the courts of final appeal upon this subject. Diligence in the examination of all attainable knowledge is all that can be claimed for the following paper, and not exhaustiveness in the high sense of "perfect understanding of the subject," which on yestermorning was laid down by our worthy President as the rule for writers of papers formally announced for discussion.

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OWNERSHIP OF THE WATER APPROPRIATED BY WATER COMPANIES.

BY A. H. DENMAN, ATTORNEY AT LAW, DES MOINES, IA.

Water, when returning to the ocean by its natural channels, is the property of no man. A stream which flows through one's premises simply gives him the right to appropriate certain of its waters and to make use of the stream subject to the equal rights of other land owners along the stream to an undiminished volume and an undeteriorated quality. Such is the common law. The ground and origin of this rule is stated by Justice Tyndale in a leading case as follows: "The right enjoyed by the proprietors of the land over which such streams flow is, and always has been, public and notorious; that the enjoyment has been long continued—in ordinary cases indeed time out of mind—and uninterrupted; each man knowing what he receives and what has always been received from the higher lands, and what he transmits and always has transmitted to the lower." (1) Under the common law, therefore, water in running streams is not property at all, neither realty nor personalty, certain privileges in the stream were all that existed. The common law rule as to the rights of riparian owners is departed from in some of the western states, and these innovations have the sanction of the Federal courts when applied to the public domain of the general government within those states. In the new country in the far west, it could not be said in the words already quoted

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1. *Acton vs. Blundel*, 12 *Mees. & W.* 324.

that the right of the proprietor of the lands over which such streams flow "is, and always has been, public and notorious," nor that it has been long continued, each man knowing what he receives and always has received and what he transmits and always has transmitted to some one else. There the first appropriator finds that in taking the water of the stream he has interfered with no one, save, perhaps, the United States, the owner of the public land, and those who settle upon the stream after he does are not allowed to question his right to do what he pleases with the water when the general government, either by act of Congress or by its silent acquiescence, has given up its rights in the matter. (1). But in these far western states as under the common law water as it exists *in the stream* is the property of no man, the difference is only as to how far a man can make the waters of the stream his own. In neither case has he such title to the waters in a stream as he has to his land. But when it is said, under the old common law, as under the law in the far west, that no property exists in the waters of a stream, it is not thereby to be inferred that the water of the stream cannot be *made* property. Much less must we infer that the nature of water, wherever found, is such that no rights of property can accrue therein. It is beyond question that percolating waters as found in wells, or oozing through the soil or standing upon the surface of the ground, belong as absolutely to the owner of the real estate as the soil itself, the trees or the minerals. And there appears to be no reason why absolute property rights cannot be acquired in water taken from a steam without perceptible diminution of its volume or other trespass upon the rights of riparian owners or under the exercise of the right of eminent domain after due reparation for the damage done.

Water courses are common in the sense that, as they are, property rights do not actually exist in them, and are open for each person to acquire property to their waters so long as he does so with due regard to the equal rights of others. (2). After one has thus appropriated water taken from a common source, it is his own, and cannot be taken from him by another without violation of the law of property. If one draws water from a river in a pail or loads it upon his water cart without wronging anybody the water is his own, and he can no doubt sell it or do what he pleases with it. It would then be clearly his personal property.

Having, therefore, determined that water can be a subject of property, we have yet to see what kind of property it is, and when is it real, and when is it personal property. If we are correct in assuming that water separated from its common source becomes the property of the appropriator, then it must follow that if the water is separated from its common source but not from the estate of the appropriator, it is a part of his estate and

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(*1*). *Atchison vs. Peterson, 20 Wall. 507; Basey vs. Gallagher 20 Wall. 670.*

(*2*). *The Mayor vs. The Commissioners, 7 Pa. St. 348; Thompson vs. Attica W. Co., 1 N. Y. Civ. P. 368; Marshall vs. Peters, 12 How. Pr. 218; Cooper vs. Williams, 4 Ohio 253; Dark vs. Johnson, 55 Pa. St. 164; Race vs. Ward, 4 Ellis & Blackburn 700.*

real property, and if separated both from its common source and from the estate, and put in a shape where it is adapted to supply needs not necessarily connected with the land on which it may temporarily be stored, or through which it may chance to pass, it is personal property. If water be appropriated for a canal or fish pond the water would no doubt be the real property of the owner of the soil, but when loaded in carts or stored in tanks for purposes not at all necessarily connected with the use or enjoyment of the premises, but for the purpose of sale to satisfy the personal necessities of consumers, it is an article of merchandise and personal property. Water as usually found in the pipes of a water company, we hold, therefore, is personal property. An exception must, probably, be made in the case of irrigating or canal companies which appropriate water in connection with the improvement of certain estates, or for the purpose of making a highway, and a damage to their rights would be a real estate trespass. But where a company organized to supply the personal wants of the population, acquires rights to appropriate water and has it in its power to transmit from place to place, furnishing it for equivalent considerations to be received, it is dealing with an article of commerce which is its personal property. (1). We must not imagine that the water so furnished is realty because the means by which it is brought to where the consumer can get it are realty. A water works plant no more makes the water distributed realty than does mill machinery make the flour it manufactures realty.

Some insist that the rate paid for a supply of water is paid for a mere privilege of getting water, and not for the water itself. By this, we suppose, it is implied that the water company takes a substance to which it has never acquired title, and in which, because of its peculiar nature, no property rights ever can be had, and puts it where every person can conveniently get it; that the water considered of itself belongs no more to the water company than it does to the person to whom it is delivered, —that, in other words, the company is merely a kind of common carrier and delivers that which is not its property. But we have seen that water may be owned and is a subject of property. Even the common carrier who takes property which belongs to some one else and by transportation makes it more valuable to the owner, acquires a qualified right of property therein, which the law recognizes by giving him a lien, as it gives to mechanics who by added material or labor, make property, real or personal, more valuable. Labor is the fountain head of all title to property. And when labor, mere transportation though it be, is bestowed upon an article in which no one has yet acquired any rights, it makes the article one's property. The stream or the source may be as open to the consumer as to the company and all others to go and get water, but after they have taken it and have it in possession, then the relation is entirely changed. The privilege of getting water as the companies offer it to us at our houses is no doubt one of the elements which makes the water valuable. In paying the price of any article we pay for a great

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(1). *Heyneman vs. Blake, 19 Cal. 579; Philadelphia vs. Gilmartin, 71 Pa. St. 140; Auman vs. Black, 15 W. Va. 773; Jones vs. W. Com. 34 Mich. 273; W. Middlesex W. Co. vs. Suwerkrop, 4 C. & P. 87.*

many privileges as well. We pay in fact for all that makes it desirable as property, one element of which is the labor which has been expended upon it in any manner. So if the water company takes water which has no value where it is, and gives it a value by making it more accessible, it argues emphatically that the water is its own peculiar property. The privilege of drawing the water may form a greater or smaller element of its value according to circumstances, but if nothing else was done than to put the water where it could be made available and useful, absolute property rights would thereby be gained to it. Labor without trespass bestowed on a thing which belongs to no man, or in which no one has yet acquired any rights, confers the right of property in the person who first acquires power over it. It is not necessary that one by his skill change the nature of the thing, but he may acquire property in any raw material or thing, which by labor of any kind—mere transportation even—he wrests from its natural position and adapts to any useful purpose. Therefore, he who steals the water which a water company has rendered more suitable for supplying the wants of man through the expenditure of its capital and labor, and which the water company has in its possession, is guilty of larceny (1). There can in this respect be no difference between gas and water, merely because the process has been carried further in the case of gas. This may affect the value to be placed upon the two but not the essential fact of property. Gas is admittedly a subject of larceny, and consequently the personal property of the gas companies (2).

Some confusion as to the principles here discussed is caused by the words "use" and "rent" as they are employed in this connection. The companies are said to grant the "use" of water, and the amount paid for the water is sometimes called a "rent" as if the water was to be returned after one was through with it. This is a misuse of terms. Water taken from the pipes of a water company is not used but consumed. Anything is consumed which is *used up*, that is, when the use that is made of it destroys its value for the purpose for which it was originally intended. The water which turns a mill is used, not consumed; but that which is employed for household purposes, bathing, washing, street sprinkling, &c., is in fact consumed, its value after such use is destroyed. One may have the use of hydrants and machinery, but he consumes the water.

It certainly cannot be urged without quibbling that because the drawing of water into the pipes and mains of a water company is continuous that there is, therefore, no severance from the reality or from the common stream to make it personalty. The severance from the realty is complete the instant a given particle of water is drawn into the pipes and is under the power of the company for distribution to consumers. The fact that it is constantly doing so does not render the severance any the less complete. Nor is the severance from the reality any the less complete because the water is drawn away from the stream, not by pumping, but by aqueducts, canals, conduits, &c., and distributed by making use of the force of gravitation or the principle that water always seeks its level. It is immaterial what

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(*1*). *Ferens vs. O'Brien, 31 Weekly Reporter, 643.*
(*2*). *Wharton Criminal Law, Sec. 1752.*

natural force is made use of to accomplish the end. The whole question, is as already stated, has the water been brought under the power of the company to use as personal property.

An interesting analogy is found in the case of oil, which the courts in Pennsylvania hold is a fluid like water. That is, as usually found in the earth, it is not property at all but can be made property by being appropriated, and when so appropriated and stored in tanks for use or awaiting transportation from place to place in pipes, it is protected by all the laws of personal property.

(1). Minerals in the western states are regarded in the same manner. There no one can fence in a tract containing minerals, as he could fence in his farm or estate, no matter how large. Minerals are there regarded as the property of no man and all have equal rights to take them, but when so taken they are the personal property of the appropriator. (2). However unwilling we may be to admit the justness of the law which treats the precious metals as common, yet this premise once admitted, the conclusion is undoubtedly correct.

The decisions governing the right of water companies to collect charges for water turn upon the law of sales of merchandise. The courts proceed consistently with the proposition that water is a commodity which is bought and sold. It is the law of personal property, not of realty, which applies. Water rents are, therefore, decided not to be taxes, although the statute makes them a lien upon the premises and enforces their collection as it does that of taxes. (3). Where the supply of water was not so good nor so abundant as to entitle the company to collect its full charge, it was, nevertheless, allowed to collect a *quantum meruit* for what was actually furnished. (4). Persons inhabiting premises not supplied with water fixtures cannot be taxed as those who do not use the water, nor can vacant lots be so assessed (5), this is, of course, to be distinguished from a general tax levied to pay for the water the city itself consumes. An office cannot be assessed as a dwelling house where people live and use more water. (6) Nor can a lodging house be made to pay the rate assessed against hotels. (7). In the case of a "model lodging" or "apartment" house, where each family lives in a distinct apartment, the company has no right to compel each family to take water through one and the same meter and share the expense equally with the others: one is entitled in such a case after making his proper connections to pay for what he himself uses. (8.) Nor on the other hand can a consumer insist upon being supplied at one rate when he retains the fixtures

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(1). *Dark vs. Johnson, 55 Pa. St. 164.*

(2). *Jennison vs. Kirk, 98 U. S. 453* (*Note at end of case on p. 462*) *Erhart vs. Boaro, 113 U. S. 527.*

(3). *Aumann vs. Black, supra.*

(4). *Failes vs Le Maire &c. 13 Lower Canada 335.*

(5). *Provident Institution for Savings vs. Allen, 37 N. J. Eq. 36.*

(6). *Shaw vs. Quebec, 16 Lower Canada 541.*

(7). *Cromwell vs. Stephens, 3 Ab. Pr. N. S. 26.*

(8). *Young vs. Boston, 104 Mas. 95.*

adapted to purposes demanding more water and entitling the company to a higher rate. He must adapt his fixtures to the rate he intends to pay. (1). The fact that the water is not expensive enough to call in all cases for the use of a meter, and that the charge is almost universally based upon an estimate more or less rough or inaccurate as to the quantity used, ought not to confuse our minds as to the real nature of the thing and the underlying principles which govern in consequence.

Again, we do not eject persons from the water, but deny water to the person. There is no action of forcible entry and detainer, nor of ejectment for refusal to pay a charge for water, but an action of assumpsit for goods sold and delivered. There is nothing like a mechanic's lien allowed for the water furnished for household purposes, and the estate is never burdened with the cost of the water so consumed, although there might possibly be a lien for the water used by a brickmason or builder, all of which shows how entirely separable from the estate and from the principles which govern the law of real property are these sales of water for consumption by the population.

And we have already seen that water rates are not taxes even when the statute engrafts upon them some of the incidents of taxes. Again, the debt is a personal one. A company cannot cut off the water from a tenant because a former occupant of the same premises defaulted his water bill (2), nor can the landlord without express agreement be held to answer for his tenant's default (3), all of which could not have been so fixed by the courts if the water furnished was in any respect regarded as an incident of the realty, or in any other sense than a purely personal matter, entirely unconnected with the use or enjoyment of the premises.

MR. BEACH:—The paper which has just been read by Mr. Denman I regard as one of the most valuable that has been presented to the Association. It seems to be complete within itself, and to close the matter in a manner that leaves no room for argument. I desire, however, if we have any time to devote to discussion, to present the question of having this paper printed in pamphlet form separate and distinct from the other proceedings. I do not mean to have it excluded from the proceedings by any means, but that there be an edition printed in advance of the regular proceedings, and that it be done at once, for I have no doubt that to some of the members the immediate possession of this paper would be worth more than the entire cost of its publication.

MR. GARDNER:—I suggest that the paper read by Mr. Denman yesterday be included, and that the two papers be issued in one pamphlet.

(*1*). *Sheffield W. Co. vs. Carter, 8 Q. B. D. 632.*
(*2.*) *Sheffield W. Co. vs. Wilkinson, 4 L. R. C. P. D. 410.*
(*3*). *Dayton vs. Quigley, 29 N. J. E. 77.*

THE SECRETARY:—I do not think it would be advisable to print, or issue, these two papers in advance of the other proceedings for several reasons. One is, there will be considerable additional expense attached. It would be well, I think, when we have the matter set up to have some extra copies printed and bound separately for any member who might wish to use them for distribution.

MR. BEACH:—In order to get the matter properly before the Association I move that the Secretary be authorized to have such number of extra copies of these papers printed as may, in his discretion, be necessary to supply the wants of the members of the Association.

The motion was adopted.

MR. BEACH:—I move that a vote of thanks be tendered Mr. Denman, for the able and thorough manner in which he has handled these subjects.

MR. DENMAN:—You must remember that there have been other papers read during this meeting just as important as my own, and I object unless this action include all papers read. I, therefore, move to amend by saying all persons who have presented papers at this meeting.

Motion adopted as amended.

THE PRESIDENT:—There are two or three committees that should report this morning. If they are ready I will call for the report of the committee to whom was referred the Doherty Pipe Joints.

THE SECRETARY:—I have been handed two reports, a minority and a majority report, which I will read in their order.

Mr. President:

On examination of the illustration of the "Doherty Pipe Coupling" presented for opinion, I do not deem it of practical utility, and from experiments frequently made, would not feel warranted in making use of it in a critical joint or on a line of main in case of introduction of special castings or insertion of a new piece of pipe, or a new pipe line. Something in the way of a new process of jointing may grow out of this interesting experiment. But it can only be looked upon as an experimental joint until more fully tried.

Respectfully, BENJ. F. STEPHENS.

Mr. President and Gentlemen of the American Water Works Association:

We, the committee, to whom was assigned the duty of making a report upon the merits of the device invented by our deceased brother Doherty, of Columbus, Ohio, feel that in the

performance of our duty—strictly on the line of duty—we have been assigned a difficult task; difficult from the fact that our duties conflict with our better feelings of sympathy for the widow of our deceased brother. We are constrained, however, to submit the following:

The device consists in substituting for the usual filling of yarn under the lead of pipe joints, a soft iron wire, or it may be presumed, not having a copy of the patent, that other material, such as copper or lead, may be substituted.

If pipe were cast of reasonably uniform size with true ends, there would be little doubt of the practicability of the device. Unfortunately we find such work so irregular that under the present average of manufacture we do not see how a wire either of lead or iron could be advantageously substituted for the yarn ordinarily used. To make the device practicable the yarn room below the lead needs to be wedge shape. This is already done by some makers, and is an improvement on the usual bead either for the wire or yarn,— part of this wedge shape should, however, be in the bowl to enable a similar use of cut pipe. As a hint to manufacturers, Mr. Doherty's devise may prove valuable, but we doubt whether many members of the Association could make such use of it as to be of material benefit to the widow of our deceased brother.

Respectfully submitted.

G. W. PEARSONS,
W. G. RICHARDS.

MR. DIVEN:—As these reports do not conflict with each other, I move the adoption of both, and that they be spread upon our record.

Adopted.

THE PRESIDENT.—The next report in order will be that of the committee to whom was referred the report of the Committee on Revision and Reprint of proceedings.

The Committee report as follows:

Mr. President and Gentlemen:

Your Finance Committee beg leave specially to report upon the matter of the publication in consolidated form and in one volume the proceedings of the first six conventions of this Association. The committee on printing have appeared before us and submitted the volume, which we find creditable to a degree. In contemplation of the reproduction of illustrative plates, there will be a financial shortage of about $200. Without committing the Association to the assumpsit of this amount, we would urge upon our members, in an *esprit du corps*, to increase the number of copies they have subscribed for. The price is fixed at $1.00 per copy and there are 200 copies on hand. The matter is to continue in the hands of the printing committee until the next annual meeting.

J. P. DONAHUE,
A. N. DENMAN,
L. H. GARDNER,
} Com.

On motion the report was adopted.

THE SECRETARY.—I desire to offer a resolution in this connection. Every member present is possibly aware that I have bitterly opposed this committee in their work. Not from any personal feeling either against the work or committee, but wholly from the fact that the resolution under which the work was done was irregular and unconstitutional; but as the work has been done and is accepted by the Association, I prove my acquiescence by presenting the following, and move its unanimous adoption:

Resolved, That the thanks of this Association be, and hereby are, tendered Mr. G. E. Beach, for the able manner in which he has performed his duty as the Chairman of the Committee on Revision and Reprint of Proceedings, notwithstanding the many difficulties attending it.

Adopted unanimously.

MR. GARDNER.—I desire to offer a motion: That the Secretary be authorized and instructed to have the matter of this meeting's proceedings electrotyped in the same form as the proceedings of former years.

Motion adopted.

MR. DONAHUE.—At the request of several members, I present a sample of one inch iron pipe, which you will observe is almost closed by a cement-like deposit of a reddish hue and as hard almost as granite.

This sample clearly illustrates that clearness of water does not necessarily mean purity, for the water which left this deposit was as clear as crystal. Not being a chemist I am unable to say what the nature of the deposit is, and can only assume that it was precipitated by the action of the steam or the heating of the water. But this letter from our Inspector, Mr. Hooper, will probably give more light upon the subject than I can.

James P. Donahue, Esq., West Hotel, Minneapolis, Minn.:

DEAR SIR—I received your dispatch asking for sample of pipe from Paint Works, which I send by express. Will state this sample was cut from the boiler feed-pipe of the Davenport Paint Works. The entire length of pipe between feed-pump and boiler was fifty feet (50), and was closed its entire length like sample. The feed water was taken from an artesian well (150) one hundred and fifty feet deep. The first notice they had of the stoppage of feed-pipe was that they could not get sufficient water in boiler. They first overhauled feed-pump, and started up with no better result. They then disconnected feed-pipe and found pipe stopped up as sample shows. My attention was called to it by the Davenport Steam Heating Company. I called upon Mr. Stearns, manager of the paint works, and asked him if he carried any insurance on the life of his engineer and on his boiler. He said he did not. I asked him if his engineer cleaned

out his boiler and made internal inspection. He replied that he did not know. He called the engineer and asked him. He replied that he washed out the boiler once a month, but did not make internal inspection. I advised him to have internal inspection made at once, as I considered that not only his property but the lives of his employes were endangered. He got badly frightened, and ordered it done at once. The internal inspection was made, and the tubes were found welded together solid with incrustation—no circulation whatever between tubes. There was taken out of that boiler seven wheelbarrowfulls of heavy scales. Mr. Stearns was badly scared, and wanted to know the remedy. Being the "doctor," I, of course, recommended frequent inspection and the well known "Donahue Water," taken in its purest state from the great Rock Island rapids. He excavated through four and a half feet ($4\frac{1}{2}$) of frost and got the water above named, and I am glad to state that he is now perfectly happy, as all others are who take the above well known water.

I remain, always your friend,

T. N. HOOPER.

THE PRESIDENT:—The selection of place of holding our next annual meeting will now be in order.

MR. DIVEN:—I think that for next year we should select some central point. I therefore name Cleveland, Ohio.

MR. TROY:—I suggest Pittsburg, Pa.

MR. DENMAN:—I am not confined to any particular point, north or south, and any place selected will suit me, but I am very favorably impressed with Baltimore, Md.

MR. LYMAN:—I will name Washington, D. C.

MR. ESPY:—I suggest Detroit, Mich.

THE PRESIDENT:—We will be very glad to have you come to Kansas City, if you do not consider it too far west, and will place it in nomination.

THE SECRETARY:—I move that an informal ballot be now taken, and that the two cities receiving the highest number of votes be placed in nomination.

Motion carried.

The ballot resulted:

Baltimore	19
Cleveland	7
Washington	4
Kansas City	3
Pittsburg	2
Detroit	2

A formal ballot was now had, Baltimore and Cleveland being in nomination, resulting as follows:

Cleveland.....27
Baltimore..... 7

Cleveland having received the majority was announced as the next place of meeting.

MR. GARDNER:—I offer the following resolution, and ask its unanimous adoption.

Resolved,—That the cordial thanks of this association are due and are hereby tendered to Col. Jno. W. Henion and his associates on the committee of arrangements and reception; to the city authorities of Minneapolis and St. Paul, for generous hospitallity; to Col. John T. West our host of the West Hotel for unremitting study of our comfort; to the press of both cities for their accurate and impartial reports of our preceedings.

Adopted unanimously.

The Committee on Nominations presented the following, for officers for the ensuing year.

President, J. T. Fanning.....Minneapolis, Minn
1st Vice President, J. M. Diven.....Elmira, N. Y
2d " W. J. Milner.....Birmingham, Ala
3d " Jno. W. Henion.....Minneapolis, Minn
4th " Jas. P. Donahue.....Davenport, Iowa
5th " H. W. Ayres.....Hartford, Conn
Secretary and Treasurer, J. H. Decker.....Hannibal, Mo
Finance Committee,... A. N. Denman.....Des Moines, Iowa
B. M. Espy.....Wilkesbarre, Pa
C. N. Priddy.....Leadville, Col

L. H. GARDNER,
CALVIN S. BROWN,
W. G. RICHARDS,
G. W. PEARSONS,
A. N. DENMAN,
Committee.

On motion the report of the committee was accepted and the chairman instructed to cast the ballot of the association for the gentlemen named.

They were declared unanimously elected.

On motion of Mr. Donahue, the thanks of the association were tendered the retiring President, Maj. B. F. Jones, for his able and impartial administration.

On motion of Mr. Richards the thanks of the association were tendered the Secretary.

MR. DENMAN:—I have been before this meeting so much that I feel that I ought to keep my seat, but there is one thing that I wish to say, and that is this: The success of this Association depends upon its members, and it is the duty, and ought to be the pleasure (which fact I do not question in the least) of each member to do what he believes will result in good to the Association. A Water Works Association, like an association of men of any other business or calling, depends for its success upon the efforts of its members. Each and every member should be ready and willing to give his assistance in the way of performing any duty that may be assigned him, or be sure to do that which he agrees and volunteers to do. I find myself derelect in not providing papers that might have been interesting and instructive to the members of the Association. I am of the opinion that an increase of attendance will be beneficial in the way of an advancement of the interests and objects of the Association, and to this end should admit and encourage the attendance of associate members. I trust that before another session, or at another session, there will be a part of the time of ths convention given to the associate members for the purpose of displaying and explaining the merits and excellence of their devices.

This, in my opinion, will be of great advantage to water works men, simply because it affords them an opportunity of getting valuable information that they could not get in any other way. So I say that at our next session I hope some arrangement will be made for a better exhibition of the devices used in our business. I would suggest that any member having any article or device that he believes to be meritorious, bring and exhibit it at our meeting.

MR. BEACH:—I agree with Mr. Denman, that some better arrangement should be made for the exhibition of devices brought here by associate members, and more encouragement and inducement offered to bring them and explain their operation and advantages.

I am impressed with the fact that a three day's session is not long enough. I think we should look forward to the time when the length of a session should be at least five days, and the latter half be devoted to a general discussion.

I do not think the Association as an Association, should advocate any particular preference to the exclusion of others, but I see no reason why they could not, with

propriety, discuss the merits of any device or machinery in which they are interested, and I can see no objection at all to associate members bringing their devices with them and discussing them and presenting their merits, and I think the Association should take some steps to afford them better facilities for so doing. As Mr. Denman has well said, it affords the members an opportunity for getting information that they could not obtain from any other source.

THE PRESIDENT:—It strikes me that the point is well taken. I have noticed for the last few meetings that the number of persons representing devices are gradually growing less, and I can see no earthly objection to allowing a man to advocate anything he has. We ought to set apart some time for this, a day or half a day.

MR. DENMAN:—To bring the matter properly before the Association, I offer this resolution:

Resolved. That the Executive Committee, in making arrangements for our next annual meeting, take into consideration the needs of associate members.

Adopted.

MR. HENION:—Before we adjourn I have a few words to say in reference to the arrangements for this afternoon and to-morrow.

This afternoon we leave the Union depot at half past 2 o'clock for St. Paul. At St. Paul you will be received by the Civil Engineers' Society and the Water Commissioners, who will have carriages in waiting to drive you to the principal points of interest, including the pumping station. At 7 o'clock supper will be served at the Hotel Ryan, and you will return here at 9 o'clock.

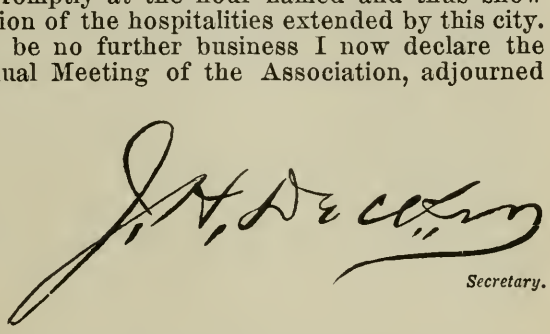
To-morrow morning it is expected that every member, with their wives and guests, will be ready to take carriages here promptly at 9 o'clock. You will be shown about the city under the supervision of Alderman Clough, returning to the "West" for dinner.

You will take the train at Union depot at 2:30 p. m. for Lake Minnetonka, where the steamer St. Louis will be in waiting, and an excursion will be taken to the lower lakes, returning to Hotel Lafayette, where supper will be served. We will return here at 10:30.

It is hoped that every one will avail himself of this opportunity to visit this beautiful body of water and famous pleasure resort. You will be amply repaid.

THE PRESIDENT:—I hope that every member will be on hand promptly at the hour named and thus show our appreciation of the hospitalities extended by this city.

If there be no further business I now declare the Seventh Annual Meeting of the Association, adjourned *sine die*.



Secretary.

NOTE.—The missing part of the Paper on the Methods of Filtration at Bombay, India, by Samuel Tomlinson, C. E., not having been received, the publication is deferred until the next Annual Proceedings.

THE SECRETARY.

UNOFFICIAL PROCEEDINGS.

Thursday Afternoon, July 14th.

After the adjournment a good majority of the members, accompanied by their ladies and guests, under the marshalship of Col. J. W. Henion, were given a ride over the Motor line to Minnehaha Falls, where a pleasant hour was spent in viewing the "Laughing Water," and being photographed, with the falls for a background.

Friday Afternoon, July 15th.

The members and friends, with quite a number of invited guests, left the Union depot at 2:30 o'clock for St. Paul, where carriages were in waiting, and the party were shown the many points of interest throughout the city; then to the Pumping Station, where a stop was had to look over the plant and to refresh the inner man. After a short rest, return was made to the city, and a halt called at the Hotel Ryan, where, after getting rid of the accumulation of dust, a most pleasant season of social chat and greeting from the members of the Civil Engineers' Club of St. Paul, assisted by the members of the Water Board, was had.

At 7 o'clock attention was directed to an elegant repast, which was served in the ordinary.

Before leaving tho supper table the following resolution was unanimously adopted:

Resolved, That the thanks of the American Water Works Association be, and hereby are, tendered to the Civil Engineers' Club, and to the Board of Water Commissioners of the City of St. Paul, for the elegant courtesies extended this day.

At 9:30 the party returned to Minneapolis, much pleased with the afternoon's entertainment.

Saturday, July 16th.

At nine o'clock a. m. carriages were in waiting and the party having embarked, were, under the guidance of Alderman D. M. Clough, driven first to the East Side Pumping Station, where a short stop was made to inspect the "Jumbo" pump. The next stop was at the famous

Pillsbury "A" Mills with its capacity of 7,200 barrels of flour per day. The party were most cordially received and in squads of eight or ten each, were accompanied by courteous guides and shown through the entire mill finishing up on the roof, where a grand view was had of the city and of St. Anthony's Falls, or rather what is left of them, for the march of manufacturing progress has almost entirely obliterated the natural falls.

After a pleasant drive through the grounds of the University of Minnesota, the river was re-crossed and the West Side, or principal pumping station of the city visited. Here every thing was found in first class order. The condition of both stations reflect great credit on the engineer in charge, Mr. A. Bergstrom and his assistants.

From the Pumping Station the party were driven to many of the interesting points in the city, its public buildings, magnificent residences and beautiful parks. Returning to the West Hotel an alarm was sounded, bringing out the Fire Department, and a very fine exhibition given, both by the steamers and the Pompier Corps. The entire display was highly creditable to both chief and members of the department, and was very interesting to to every member of the Association.

At 2:30 p. m. the party left the Union Depot for Lake Minnetonka. The afternoon was pleasantly, and no doubt profitably, spent in an excursion around the lake, returning to Hotel LaFayette, where at 7:30, supper was spread in the spacious dining room. After the *menu* had received full attention, toasts were in order, and were responded to by Mayor Ames, Col. Gardner, President Fanning, Secretary Decker and others.

IN MEMORIAM.

R. G. ANDERSON,

MECHANICAL ENGINEER, SCRANTON, PENNSYLVANIA.

DIED DECEMBER 5, 1886.

R. G. ANDERSON was born at Holyoke, Mass., April 11th, 1862. He was raised and educated at Whitinsville, Mass., and early developed a taste for draughting. Upon leaving school he attended a special class in draughting; after which he entered the designing room of the German Silver Works at Providence, R. I.; from there he served with Brown & Sharp, the R. I. Locomotive Works, American Vacuum Brake Co., E. P. Allis & Co., and others. Early in 1885 he went to Scranton, Pa., entering the office of the Lackawanna Iron and Coal Co., where he was employed at the time of his death. He was taken ill with Pneumonia Nov. 28th and died December 5th.

Mr. Anderson was a man of sterling habits, a member of the Providence Congregational Church of Providence, R. I., and one who stood high in the esteem and confidence of his employers as well as in the regards of his associates.

He was unmarried and left father, mother, two sisters and three brothers, to whom the Association extends its warmest sympathy.

FINANCIAL REPORT.

1886.			Dr.	Cr.
June 23.	Balance on hand.....		$ 36 00	
"	A. A. Godard,	Entrance Fee,	5 00	
"	W. G. Richards,	" "	5 00	
"	H. C. Heermans,	" "	5 00	
"	Chas N. Priddy,	" "	5 00	
"	Geo. A. Shields,	" "	5 00	
"	Wm. Bowen,	" "	5 00	
"	E. W. Frost,	" "	5 00	
"	Myron Wiltsie,	" "	5 00	
"	Wm. B. Mills,	" "	5 00	
"	Louis Harper,	" "	5 00	
"	J. H. Dumont,	" "	5 00	
"	Chas. T. Allen,	" "	5 00	
"	Richard Holme,	" "	5 00	
"	W. G. Provines,	" "	5 00	
"	Jas. P. Maxwell,	" "	5 00	
"	Geo. W. Brown,	" "	5 00	
"	N. Kuhnen,	" "	5 00	
"	James Archer,	" "	5 00	
"	H. S. McConnell,	" "	5 00	
"	J. I. Jones,	" "	5 00	
"	Geo. F. Swain,	" "	5 00	
"	Reading Iron Works,	" "	10 00	
"	E. H. Kellogg & Co.,	" "	10 00	
"	Davis, Cresswell & Co.,	" "	10 00	
"	Ted, Wortley & Co.,	" "	10 00	
"	W. W. Sprague,	Dues to 1886,	3 00	
"	G. E. Beach,	" "	3 00	
"	A. N. Denman,	" "	3 00	
"	W. J. Milner,	" "	3 00	
"	H. Mueller,	" "	3 00	
"	R. D. Wirt,	" "	3 00	
"	P. Milne, Jr.,	" "	3 00	
"	J. M. Diven,	" "	3 00	
"	P. J. Neagle,	" "	3 00	
"	R. Holme, Jr.,	" "	3 00	
"	H. F. Dunham,	" "	3 00	
"	John C. Chase,	" "	3 00	
"	H. D. Wood,	" "	3 00	
"	Chas. N. Priddy,	Dues to 1887,	3 00	
"	W. G. Richards,	" "	3 00	
"	Jno. W. Troy,	" "	3 00	
"	W. L. Cameron,	" "	3 00	
"	J. H. Dumont,	" "	3 00	
"	E. W. Frost,	" "	3 00	
"	G. W. Brown,	" "	3 00	
"	J. P. Maxwell,	" "	3 00	
"	Geo. A. Shields,	" "	3 00	
"	J. T. Sawyer,	" "	3 00	
"	I. L. Lyman,	" "	3 00	

1886.			Dr.	Cr.
June 23.	Chas. P. Allen,	Dues to 1887,	$ 3 00	
"	Frank W. Holly,	" "	3 00	
"	H. F. Gaskell,	" "	3 00	
"	P. H. Linneen,	" "	3 00	
"	Geo. A. Ellis,	" "	3 00	
"	E. L. Dunbar,	" "	3 00	
June 28.	G. W. Robinson,	Entrance Fee,	5 00	
July 9.	J. L. Hanna,	" "	5 00	
July 14.	N. O. Nelson Mfg. Co.,	Dues to 1886,	3 00	
"	H. H. Harrison,	" "	3 00	
"	Abendroth & Root,	" "	3 00	
"	Jarecki, Hays & Co.,	" "	6 00	
"	Jones & Laughlins,	" "	3 00	
"	Geo. F. Blake Mfg. Co.,	" "	3 00	
"	J. L. Mott Iron Works,	" "	3 00	
"	L. H Gardner,	" "	3 00	
"	J. D. Houston,	" "	3 00	
"	Dennis Long & Co.,	" "	3 00	
July 15.	Wm. Ludlow,	" "	3 00	
"	The Eddy Valve Co.,	" "	3 00	
"	Bingham & Taylor,	" "	3 00	
"	Geo. B. Inman,	" "	3 00	
"	H. R. Worthington,	" "	3 00	
"	J. M. Randall,	" "	3 00	
"	I. S. Cassin,	On account, 1887,	5 00	
"	M. W. Kirk		3 00	
"	The Michigan Pipe Co		3 00	
"	R. D. Wood & Co		3 00	
"	W. S. Kuhn		3 00	
July 16.	Newark Filtering Co		3 00	
"	J. H. McMinn		3 00	
"	J. H. Andrew		3 00	
"	National Meter Co.,	Dues to 1887,	6 00	
July 17.	P. B. Perkins,	" 1886,	3 00	
"	Equitable Water Meter Co.,	" "	3 00	
"	G. C. Stevens,	" "	3 00	
"	Ludlow Valve Mfg. Co.,	" "	3 00	
"	The Ohio Pipe Co.,	" "	3 00	
"	Desmond Fitzgerald,	" "	3 00	
"	Cinn. & Newport I. & P. Co.,	" "	3 00	
July 19.	James P. Donahue,	" "	3 00	
"	Thos. N. Hooper,	" "	3 00	
"	Ezra Clark,	" 1887,	3 00	
"	H. W. Ayres,	" "	3 00	
"	National Tube Works Co.,	" 1886,	3 00	
"	Fred Adee & Co.,	" "	3 00	
"	A. F. Kent,	" "	3 00	
July 20.	Ripley & Kimball,	" "	3 00	
"	L. J. LeConte,	" "	3 00	
"	D. L. Holland,	" "	3 00	
July 21.	J. G. Briggs,	" "	6 00	
"	W. H. Marsh, Mgr.,	" "	3 00	
"	Moses Joy, Jr.,	" "	3 00	
July 23.	W. R. Billings.	" "	3 00	
"	Robert Moore,	" "	3 00	
"	Edwin Darling,	" "	3 00	

1886.			Dr.	Cr.
July 23.	Chapman Valve Co.,	Dues to 1886,	$ 3 00	
"	John Ryle,	" "	3 00	
"	Wm. Ryle,	" "	3 00	
July 26.	A. H. Martine,	" 1887,	6 00	
"	J. T. Fanning,	" 1886,	3 00	
"	Gordon Maxwell Co.,	" "	3 00	
"	Wm. T. Porter,	" "	3 00	
"	Lewis C. Burnes,	" "	3 00	
"	Carroll E. Gray,	" "	3 00	
July 28.	E. S. Wills,	" "	3 00	
"	C. W. Morse,	" "	3 00	
"	John W. Hill,	" "	6 00	
July 30.	J. Nelson Tubbs,	" "	3 00	
Aug. 2.	L. A. Taylor,	" "	3 00	
"	M. L. Holman,	" "	3 00	
"	Wm. B. Sherman,	" "	3 00	
"	R. C. P. Coggeshall,	" "	3 00	
"	Robt. K. Martin,	" "	3 00	
Aug. 4.	A. W. Morgan,	" "	3 00	
"	B. F. Jones	" "	3 00	
"	G. W. Pearsons,	" "	3 00	
"	Fred Wing,	" "	3 00	
Aug. 5.	N. Wingfield,	" "	3 00	
"	H. G. Holden,	" "	3 00	
"	Hardwicke & Ware,	" "	3 00	
"	P. Connelly,	" "	3 00	
"	J. A. Cloud,	" "	3 00	
Aug. 6.	J. Henry Brown,	" "	3 00	
"	F. L. Fuller,	" "	3 00	
"	Walter Watson,	Entrance Fee,	5 00	
Aug. 13.	L. H. Williams,	Dues to 1886,	3 00	
Aug. 19.	John Martin,	" "	6 00	
Aug. 26.	Davidson Steam Pump Co.,	" "	3 00	
Aug. 27.	Wm. B. Bull,	" "	3 00	
Sept. 2.	T. S. Moorehead,	" "	3 00	
Sept. 5.	C. S. Brown,	" "	6 00	
Sept. 7.	W. S. Payne,	" "	3 00	
Sept. 16.	Chas. A. Hague,	" "	3 00	
Sept. 27.	G. W. Pearsons,	" 1887	3 00	
Oct. 6.	R. G. Elwes,	Entrance Fee,	5 00	
"	J. D. Cook,	" "	5 00	
Oct. 8.	B. M. Espy,	Dues to 1886,	3 00	
Nov. 1.	Chas. B. Brush,	" "	6 00	
Nov. 17.	Rudolph Hering,	Entrance Fee,	5 00	
"	Rudolph Hering,	Dues to 1887.	3 00	
Nov. 18.	Chas. G. Price,	" 1886,	3 00	
"	J. H. Decker,	" "	6 00	
Nov. 20.	James Waters,	" "	3 00	
Nov. 33.	F. A. W. Davis,	" "	3 00	
"	J. B. Johnson,	Entrance Fee,	5 00	
Nov. 24.	J. B. Clow & Sons,	Dues to 1886,	3 00	
Nov. 26.	R. G. Anderson,	" "	3 00	
"	Henry Birkinbine,	" "	3 00	
"	A. H. Howland,	" "	3 00	
"	W. S. Hamilton,	" "	6 00	
"	A. J. Jones,	" "	3 00	

1886.			Dr.	Cr.
Nov. 26.	Gilbert Murdock,	Dues to 1887	$ 6 00	
"	Deane Steam Pump Co.,	Entrance Fee,	10 00	
"	" "	Dues to 1887,	3 00	
"	A. G. Moore,	" to 1886,	6 00	
Nov. 29.	D. McN. Stauffer,	" "	6 00	
"	Sylvester Watts,	" "	3 00	
"	Shickle, H. & H. Iron Co.,	" "	3 00	
"	Wm. H. Searles,	Entrance Fee,	5 00	
"	Wm. H. Searles,	Dues to 1887,	3 00	
Dec. 1.	E. H. Keating,	" 1886,	6 00	
Dec. 3.	A. Schaeffer,	" "	3 00	
Dec. 4.	Frank H. Pond,	" "	3 00	
Dec. 8.	Philip Beuhner,	" "	3 00	
Dec. 10.	Geo. H. Chandler,	" "	3 00	
Dec. 13.	Wm.H. Burnham,	" "	3 00	
Dec. 14.	J. Albert Mills,	" "	3 00	
Dec. 15.	B. R. Morton,	" 1887,	9 00	
Dec. 18.	Jos. E. Hannah,	Entrance Fee,	5 00	
"	Jos. E. Hannah,	Dues to 1887,	3 00	
Dec. 27.	W. C. Stripe,	" 1886,	6 00	
Dec. 29.	Jno. C. Kupferle,	Entrance Fee,	10 00	
1887.				
Jan. 10.	S. Tomlinson,	" "	5 00	
"	S. Tomlinson,	Dues to 1888,	3 00	
"	Howard Elmer,	Entrance Fee,	5 00	
"	Chattanooga F. & P. Works,	" "	10 00	
"	Chattanooga F. & P. Works,	Dues to '88,	3 00	
Jan. 21.	Edward H. Phipps,	Entrance Fee,	5 00	
"	Edward H. Phipps,	Dues to 1888,	3 00	
Jan. 29.	H. M. Newton,	" 1887,	3 00	
Feb. 1.	Sam'l McElroy,	" "	3 00	
"	Nisbet Wingfield,	" 1888,	6 00	
Feb. 20.	Dexter Bracket,	" 1886,	3 00	
March 7.	Chas. F. Manning,	Entrance Fee,	5 00	
"	Chas. F. Manning,	Dues to 1888,	3 00	
March 12.	Wm. Perry, Jr.,	" 1886,	3 00	
March 17.	Hersey Meter Co.,	Entrance Fee,	10 00	
"	Hersey Meter Co.,	Dues to 1888,	3 00	
March 21.	E. H. Brown, bal.	" 1886,	2 00	
March 28.	Wm. Molis,	" 1887,	3 00	
May 13.	John Caulfield,	Entrance Fee,	5 00	
May 25.	Wm. Fisher,	" "	5 00	
June 2.	Andrew Rinker,	" "	5 00	
"	Matt. Walsh,	" "	5 00	
"	C. S. Brown,	Dues to 1887,	3 00	
June 11.	A. S. Glover,	" 1886,	3 00	
June 23.	D. J. McCanne, on acc't	Dues to 1887,	5 00	
June 27.	D. L. Holland,	" "	3 00	
June 29.	Geo. Hornung,	Entrance Fee,	5 00	
"	Geo. Hornung,	Dues to 1888,	3 00	
"	H. L. Smith,	Entrance Fee,	5 00	
"	Jno. R. Todd,	" "	5 00	
"	"	Dues to 1888,	3 00	
"	H. L. Smith,	" "	3 00	
"	John P. Hely,	" 1887,	3 00	
July 2.	R. Beaumont,	Entrance Fee,	10 00	

1887.			Dr.	Cr.
July 2.	R. Beaumont,	Dues to 1888,	$ 3 00	
July 7.	Wilson Henderson,	Entrance Fee,	5 00	
"	"	Dues to 1888,	3 00	
"	Sundry Sales of Proceedings		8 20	
1886.				
June 23.	Paid Porterage on Books			$ 50
June 30.	" " "			50
July 8.	" Postage			4 00
July 19.	" H. L. Denison, Stenographer			90 00
July 20.	" Postage			2 00
"	" Express Charges			35
July 23.	" "			30
July 26.	" Collection of Checks			30
Aug. 12.	" " "			30
Aug. 18.	" Postage			2 00
Aug. 20.	" Seal Wafers			25
Sept. 19.	" Collection of Checks			25
Oct. 28.	" Postage			2 00
Nov. 4.	" Rubber Bands			1 50
Nov. 6.	" Postage			20 00
Nov. 13.	" "			15 00
Nov. 24.	" "			2 00
Dec. 1.	" "			4 00
"	" Collection on Check			20
Dec. 30.	" W. C. Stripe, Bill Postage			1 00
1887.				
Jan. 6.	" Express Charges			25
Jan. 16.	" Postage			25
Jan. 21.	" Collection Charges on Check			15
Jan. 22.	" Postage			2 00
"	" Standard Printing Co			265 70
M'ch 3.	" Postage			2 00
May 4.	" "			25
May 25.	" "			2 00
May 31.	" "			50
June 22.	" "			15 00
July 5.	" Book Trunk			2 00
"	" Postage			2 70
July 7.	" Paper Pins			20
"	" Trunk Strap			75
July 9.	" Standard Pt'g Co			35 00
July 13.	" J. H. Decker, salary			200 00
	Balance cash on hand			230 00
			$905 20	$905 20

LIST OF MEMBERS.

HONORARY.

Y. Nakajima, Imperial University.....Tokio, Japan

ACTIVE.

Allen, Chas. P., Engineer Waterworks.....Denver, Col
Andrew, Jas. H., Sup't Waterworks.....Central Falls, R. I
Archer, James, Water Co.....Denver, Col
Ashford, Z. M., Mechanical Eng., Waterworks.....Newport, Ky
Avery, Wm. H., Sup't Waterworks.....Port Huron, Mich
Ayres, H. W., C. E. Waterworks.....Hartford, Conn
Babcock, S. E., C. E. Waterworks.....Little Falls, N. Y
Ball, Phinehas, Hydraulic Engineer.....Worcester, Mass
Beach, G. E., Hydraulic Engineer.....Minneapolis, Minn
Bergstrom, Andrew, Mech. Eng. Waterw'ks...Minneapolis, Minn
Birkinbine, Harry C. E. Waterworks.....Council Bluffs, Ia
Bixby, Walter A., Sup't Waterworks.....Galena, Ill
Bowen, Wm., Sup't Waterworks.....Oskaloosa, Ia
Briggs, J. G., Sup't Waterworks.....Terre Haute, Ind
Brown, Calvin S., with National Meter Co.....New York, N. Y
Brown, E. H.....Grass Valley, Cal
Brown, Geo. W., Sup't Waterworks.....Longmont, Col
Brown, J. Henry, Sup't Mystic Div. Water Dep't...Boston, Mass
Brush, Chas. B., C. E. and Sup't Waterworks.....Hoboken, N. J
Buehner, Philip, Waterworks Contractor.....St. Paul, Minn
Bull, Wm B., Sup't Waterworks.....Quincy, Ill
Burnes, L. C., Secretary Water Co.....St. Joseph, Mo
Cameron, W. L., Sec'y and Supt. Waterworks.....Memphis, Tenn
Carson, J. M., C. E. and Supt. Waterworks.....Danville, Ill
Cassin, Isaac S., Hydraulic Engineer.....Philadelphia, Pa
Caulfield, John, Sec'y Water Board.....St. Paul, Minn
Chandler, Geo. H., Engineer Waterworks.....Kalamazoo, Mich
Chase, John C., C. E. and Supt. Waterworks...Wilmington, N. C
Clark, Ezra, Pres't and Supt. Water Commission...Hartford, Conn
Cloud, J. A., Constructing Engineer.....Jacksonville, Fla
Coggeshall, R. C. P., Supt. Waterworks.....New Bedford, Mass
Conant, Whitney, Sec'y Water Co.....Long Branch, N. J
Cook, J. D., Consulting Eng neer.....Toledo, Ohio
Croes, J. J. R., Consulting Engineer.....New York, N. Y
Darling, Edwin, Supt. Waterworks.....Pawtucket, R. I
Davis, F. A. W., V.-Pres. and Treas. Water Co...Indianapolis, Ind
Davis, T. W., Mech. Eng. with H.R. Worthington, New York, N.Y
Decker, J. H., Engineer and Supt. Water Co.....Hannibal, Mo
DeLuce, Wm. T., Engineer.....Chicago, Ill
Denman, A. N., Sec'y Water Co.....DesMoines, Ia
Diven, J. M., Sec'y and Treas. Water Co.....Elmira, N. Y
Donahue, Jas. P., Vice-Pres. and Supt. Water Co...Davenport, Ia
Drummond, C. S., Director Water Co.....Winnipeg, Can
Dumont, J. H.....Omaha, Neb

Dunbar, E. L., Sec'y and Sup't Waterworks.....Bay City, Mich
Dunham, H. F., Consulting Engineer.....Cleveland, Ohio
Eaton, Frederick, Consulting Engineer.....Los Angelos, Cal
Ellis, Geo. A., Chief Engineer Waterworks.....Racine, Wis
Elmer Howard, Pres't Sayre, Pa., Water Co.....Waverly, N. Y
Elwes, R. Gervase, Civil and Consulting Eng.....London, Eng
Espy, B. M., Sec'y and Treas. Waterworks.....Wilkesbarre, Pa
Fanning, J. T., Civil and Consulting Eng.....Minneapolis, Minn
Fisher, Wm., Supt. Waterworks.....Marshalltown, Ia
Fitzgerald, Desmond, C. E. and Supt. Water Dept...Boston, Mass
Foster, J. T., Civil Engineer.....Chicago, Ill
Frost, E. W., Sup't Waterworks.....Colorado Springs, Col
Fry, D. C., Sup't Waterworks.....Jacksonville, Ills
Fuller, F. L., Constructing Engineer.....Boston, Mass
Gardner, L. H., Sup't Water Co.....New Orleans, La
Getchell, W. H., Sec'y Faribault Water Co.....Minneapolis, Minn
Glover, A. S., Water Registrar.....Newton, Mass
Godard, A. A., President Water Co.....Clay Centre, Kas
Golding, Wm., Mechanical Engineer.....New Orleans, La
Gow, R. M., Sup't Waterworks.....Medford, Mass
Gray, Carroll E., Contractor and Builder.....Waukesha, Wis
Hague, C. A., Mec. Eng. with Knowles S. P. Co., New York, N. Y
Hamilton, W. S., Sup't Waterworks.....Youngstown, Ohio
Hanna, J. L., Prest. and Manager Water Co.....Franklin, Pa
Hannah, Jos. E., Eng. and Sup't Waterworks.....Winnipeg, Can
Harlow, Geo. R., Constructing Engineer.....Pittsburgh, Pa
Harper, Louis, Sup't of Construction.....Rapid City, Dak
Harrison, H. H., Sup't Waterworks.....Stillwater, Minn
Heermans, H. C., Sup't Waterworks.....Corning, N. Y
Hely, John P., Civil and Hydraulic Engineer.....St. Louis, Mo
Henion, J. W., Sup't Waterworks.....Minneapolis, Minn
Henderson, Wilson, Sup't Waterworks.....Peterborough, Ont
Hering, Rudolph, Chf. Eng. Drainage and Water Sup., Chicago, Ill
Hill, John W., Mech. Eng.....Cincinnati, Ohio
Holden, H. G., Sup't Waterworks.....Lowell, Mass
Holland, D. L., Eng and Sup't Waterw'ks, Saratoga Springs, N. Y
Holly, Frank W., Mechanical Engineer.....Lockport, N. Y
Holman, M. L., Water Commissioner.....St. Louis, Mo
Holme, Richard, Sec'y and Sup't Water Co.....Denver, Col
Holme, Richard, Jr., Cashier Water Co.....Denver, Col
Hood, Chas., Sup't Waterworks.....Burlington, Ia
Hooper, Thos. N., Chief Engineer Waterworks.....Davenport, Ia
Hornung, Geo., Civil Engineer.....Newport, Ky
Houston, Jas. D., Pres't Water Co.....New Orleans, La
Howland, A. H., Constructing Engineer.....Boston, Mass
Inman, Geo. B., Contracting Engineer.....New York, N. Y
Johnson, J. B., Prof. Civil Eng. Washington Univ.....St. Louis, Mo
Jones, A. J., Sup't and Treas. Waterworks, New Brunswick, N. J
Jones, B. F., Sup't Water Co.....Kansas City, Mo
Jones, J. I., Sup't Waterworks.....Leavenworth, Kas
Jones, R. M., Manager Waterworks.....Wyandotte, Kas
Joy, Moses, Jr., President Water Co.....Milford, Mass
Keating, E. H., City Engineer.....Halifax, Nova Scotia
Keeler, H. E., Director Charleston, Ill., Water Co.....Chicago, Ill
Kent, A. F., Pres't and Sup't Water Co.....Jamestown, N. Y
Kuhn, W. S., Contracting Engineer.....McKeesport, Pa
Kuhnen, N., Pres't Water Co.....Davenport, Ia

LeConte, L. J., Civil and Consulting Engineer.....Oakland, Cal
Linneen, P. H., Mechanical Engineer.....Lockport, N. Y
Loweth, Chas. F., Civil Engineer.....St. Paul, Minn
Ludlow, Wm., Engineer Comm'r, U. S. A.....Washington, D. C
Lyman, I. L., Comm'r and Sup't Waterworks.....Lincoln, Neb
McCanne, D. J., Sup't Waterworks.....Gunnison, Col
McClary, W. F., Sup't Waterworks.....Mt. Pleasant, Ia
McConnell, H. S., Sec'y Water Co.....New Brighton, Pa
McElroy, Samuel, Civil Engineer.....Brooklyn, N. Y
McIntire, H. B., Chief Engineer Water Dep't...Wilmington, Del
McMinn, J. H., Sup't Waterworks.....Williamsport, Pa
Manning, Chas. F. Sup't Waterworks.....Hagerstown, Md
Martin, John, Engineer Waterworks...St. Johns, Newfoundland
Martin, Robert K., Chief Engineer Water Dep't...Baltimore, Md
Martine, A. H., Eng. and Sup't Waterworks.....Knoxville, Tenn
Maxwell, J. P., Civil Engineer.....Boulder, Col
Mills, J. Albert, Sup't Waterworks.....St. Catherines, Ont
Mills, Wm. B., Pres't Water Co.....Denver, Col
Milne, Peter, Jr., Consulting Engineer.....New York, N. Y
Milner, W. J., Sec'y and Sup't Waterworks.....Birmingham, Ala
Molis, Wm., Sup't Waterworks.....Muscatine, Ia
Moody, Frank F., Registrar Water Dep't.....Minneapolis, Minn
Moore, A. G., Engineer and Sup't Water Dep't.....Cincinnati, O
Moore, D. F., Sup't Waterworks.....Phœnixville, Pa
Moore, M. M., Civil Engineer.....Dayton, Ohio
Moore, Robert, Civil Engineer.....St. Louis, Mo
Moorhead, T. S., Civil and Hydraulic Engineer.....Milton, Pa
Morse, C. W., Sup't Waterworks.....Haverhill, Mass
Morton, B. R., C. E. and Sup't Waterworks.....Newport, Ky
Murdock, Gilbert, C. E. and Sup't Waterworks...St. Johns, N. B
Neagle, P. J., Sup't Waterworks.....Elmira, N. Y
Newton, H. M., Sec'y and Sup't Waterworks..East Saginaw, Mich
Noyes, A. F., Chief Engineer Waterworks.....Newton, Mass
Parrott, H. C., Mechanical Engineer.....Lockport, N. Y
Pearsons, G. W., Chief Engineer Water Co.....Kansas City, Mo
Pearsons, R. C., Ass't Eng. K. C. Water Co.....Wyandotte, Kas
Perkins, P. B., Contracting Engineer.....Springfield, Mo
Phipps, E. H., Sup't Waterworks.....West Haven, Conn
Pond, F. H., Mechanical Engineer.....St. Louis, Mo
Perry, Wm. Jr., Constructing Engineer.....Montreal, Quebec
Porter, Wm. T., Pres't Board Water Com'rs.....Wilmington, Del
Price, Chas. G., Cashier for Water Co.....Hannibal, Mo
Priddy, Chas. N., Sec'y and Sup't Waterworks.....Leadville, Col
Ræder, F. Wm., Consulting Engineer.....St. Louis, Mo
Randell, J. M., Supt Waterworks.....East Orange, N. J
Rensford, C. C., Chief Engineer Waterworks.....Covington, Ky
Reyer, Geo., Sup't Waterworks.....Nashville, Tenn
Rhodes, Benj., Eng. and Sec'y Waterworks...Niagara Falls, N. Y
Richards, W. G., Sup't Waterworks.....Atlanta, Ga
Richmond, Alex., Sup't Street Dep't Waterworks...Dayton, Ohio
Rinker, Andrew, City Engineer.....Minneapolis, Minn
Robinson, Geo. W., Director of Water Co.....Winfield, Kas
Rundlett, L. W., Chief Engineer Water Dept.....St. Paul, Minn
Ryle, John, President Water Co.....Paterson, N. J
Ryle, Wm., Superintendent Water Co.....Paterson, N. J
Sawyer, J. T., President Water Co.....Waverly, N. Y
Schæfer, August, Sup't Waterworks.....Maysville, Ky

Schefold, Frank, Sup't Waterworks.....New Albany, Ind
Schon, Carl, Civil Engineer.....Toledo, Ohio
Searles, W. H., Civil and Consulting Engineer....Cleveland, Ohio
Sekell, A. C., Consulting Engineer.....Grand Rapids, Mich
Sherman, W. B., Mechanical Engineer.....Providence, R. I
Shields, Geo. A., Superintendent Waterworks.....Pueblo, Col
Smith, Herbert L., Sup't Waterworks.....Norfolk, Va
Sprague, W. W., Chief Eng. Waterworks.....Town of Lake, Ill
Stauffer, D. Mc. N.. C. E., Ed. "Eng. News".....New York, N. Y
Stephens, Benj. F., Constructing Engineer.....Flatbush, N. Y
Stevens, G. C.....Newport, R. I
Stripe, W. C., Sec'y and Sup't Waterworks.....Keokuk, Ia
Swain, Chas. R., Sup't Waterworks.....Peekskill, N. Y
Swain, Geo. F., Prof. C. E. Mass. Inst. of Tech.....Boston, Mass
Taylor, L. A., Constructing Engineer.....Worcester, Mass
Troy, John W., Superintendent Waterworks.....Pierre, Dak
Todd, John R., Registrar Water Dep't.....Norfolk, Va
Tomlinson, Samuel, Dep. Ex. Eng. Waterw'ks.....Bombay, India
Tubbs, J. Nelson, Chief Eng. Waterworks.....Rochester, N. Y
VanCleve, H. S., Dir. Pierre, Dak., Water Co..Minneapolis Minn
Walsh, Matt. Sup't Waterworks.....Minneapolis, Minn
Waltz, Jos. E., City Engineer.....Dayton, Ohio
Waters, James, Chief Eng. Waterworks.....Minneapolis, Minn
Watson, Walter, Civil Engineer.....Pittsfield, Mass
Watts, Sylvester, Contracting Engineer.....St. Louis, Mo
Weller, John, Inspector Waterworks.....East Saginaw, Mich
Willard, W. H., Sup't Waterworks.....Eau Claire, Wis
Williams, L. H., Sec. & Treas New Castle Water Co...Pittsburg Pa
Wills, E. S., Superintendent Water Co.....Atchison, Kas
Wiltsie, Myron, Engineer of Construction.....Rapid City, Dak
Wing, Fred. Cashier for Water Co.....Kansas City, Mo
Wingfield, N., Chief Eng. Waterworks.....Chattanooga, Tenn
Wirt, R. D., Superintendent Waterworks.....Independence, Mo
Wood, H. D., Sec. and Treas. Hannibal Water Co..St. Louis, Mo.

ASSOCIATE.

Adee, Fred & Co., No. 52 Cliff st.....New York, N. Y
Beaumont, Richard.....Kankakee, Ill
Bingham & Taylor, Clinton & Jackson sts.....Buffalo, N. Y
Blake, Geo. F. Mfg. Co., Nos. 95–99 Liberty st...New York, N. Y
Chandler & Swift.....Buffalo, N. Y
Chapman Valve Mfg. Co.....Indian Orchard, Mass
Chattanooga Foundry & Pipe Works.....Chattanooga, Tenn
Cincinnati & Newport Iron and Pipe Co.....Newport, Ky
Clow, J. B. & Sons, Lake and Franklin st.....Chicago, Ills
Columbus Water Works.....Columbus, Ohio
Connelly P., No. 351 Adams st.....Brooklyn, N. Y
Davidson Steam Pump Co., No. 41–51 Keap st .....Brooklyn, N. Y
Davis, Cresswell & Co.....Denver, Col
Deane Steam Pump Co.....Holyoke, Mass
Eddy Valve Mfg. Co.....Waterford, N. Y
Equitable Water Meter Co., No. 36 India Wharf.....Boston, Mass
Galvin Brass and Iron Works..... ....Detroit, Mich
Gaskell, H. F., Holly Mfg. Co.....Lockport, N. Y
Gordon Maxwell Co.....Hamilton, Ohio
Hardwicke & Ware.....Buffalo, N. Y

Hayes, Geo. B.....Buffalo, N. Y
Hays Mfg. Co.....Erie, Pa
Hersey Meter Co.....Boston, Mass
Hooker, Wm. D., No 1101 North Second st.....St. Louis, Mo
Jones & Laughlins, No. 28 West Lake st.....Chicago, Ill
Kellogg, E. H. & Co., No. 17 Cedar st.....New York, N. Y
Kupferle, John C.....St. Louis, Mo
Long, Dennis & Co.....Louisville, Ky
Ludlow Valve Mfg. Co.....Troy, N. Y
McNeil, A. H.....Burlington, N. J
Marsh, W. H., Man. Tuerk Hydraulic Power Co..New York, N. Y
Michellon, J. P.....Camden, N. J
Michigan Pipe Co.....Bay City, Mich
Morgan, A. W., No. 11 Forest Ave.....Buffalo, N. Y
Mott, J L., Iron Works, No. 88 & 90 Beekman st..New York, N. Y
Mueller H.....Decatur, Ill
National Meter Co., No. 252 Broadway.....New York, N. Y.
National Tube Works Co.....McKeesport, Pa
Nelson, N. O., Mfg. Co. 8th and St. Charles sts.....St. Louis, Mo
Newark Filtering Co., Tribune Building.....New York, N. Y
Ohio Pipe Co.....Columbus, Ohio
Payne, W. S.....Fostoria, Ohio
Reading Iron Works, Nos 16 and 18 North 5th st..Philadelphia, Pa
Ripley & Bronson, Nos. 907-911 North Main st.....St. Louis, Mo
Robertson, R. A. Jr., Agent.....Providence, N. J
Roosevelt, C. H.....New Rochelle, N. Y
Shickle, Harrison & Howard Iron Co.....St. Louis, Mo
Strang, Samuel A., No. 30 Pine st.....New York, N. Y
Union Water Meter Co.....Worcester, Mass
Volker & Felthousen Mfg. Co.....Buffalo, N. Y
Wood, R. D. & Co., No. 400 Chestnut st.....Philadelphia, Pa
Worthington, H. R., Nos. 86 and 88 Liberty st...New York, N. Y
Wortley, Ted & Co.....Kansas City, Mo

Report of Proceedings

OF THE

Eighth Annual Meeting

OF THE

American * Water * Works

ASSOCIATION.

HELD AT

CLEVELAND, OHIO.

April 17th, 18th and 19th, 1888.

HANNIBAL, MO.:
STANDARD PRINTING CO.
1888.

OFFICERS FOR 1888-9.

President,

A. N. DENMAN, - - - Des Moines, Iowa.

Vice-Presidents,

J. M. DIVEN, - - - - Elmira, New York.
W. G. RICHARDS, - - - - Atlanta, Ga.
JNO. W. HENION, - - - Minneapolis, Minn.
CHAS. N. PRIDDY, - - - Leadville, Colo.
H. W. AYRES. - - - - - Hartford, Conn.

Secretary and Treasurer,

J. H. DECKER, - - - - - Winfield, Kas.

Finance Committee,

FRANK W. HOLLY, - - - Lockport, N. Y.
F. L. FULLER, - - - - - Boston, Mass.
THOS. N. HOOPER, - - - Davenport, Iowa.

Past Presidents,

J. T. FANNING, - - - - Minneapolis, Minn.
B. F. JONES, - - - - Kansas City, Mo.
PETER MILNE, JR., - - - New York, N. Y.
L. H. GARDNER, - - - New Orleans, La.
J. G. BRIGGS, - - - - - Chicago, Ill.
J. T. FOSTER, - - - - - Chicago, Ill.

The Ninth Annual Meeting will be held at Louisville, Ky., April 16th–18th, 1889.

INDEX.

	PAGE.
Anchor Ice	123
Baltimore Waterworks, (Illustration)	44
Cleveland Waterworks	114
Condensers on Pumping Engines	133
Election of Officers	169
Exhibits by Non-members	89
Feed Water Heaters	131
Financial Report	176
In Memoriam	174–175
Liquid and Gaseous Fuels	154
List of Members	181
One Phase of the Problem	89
Place of next Meeting	170
Plan of Well for Kalamazoo Waterworks	24
Plumbers—Judge Gill's Decision	64
Practical Results of Mechanical Filtration	148
Quindaro Settling Basin and Siphon Well	56
Recent Filtration Practice in India	139
Redwood Pipe, (Illustrations)	40–41
Relative Value of Coal and Petroleum as Fuel	118
Report of Executive Committee	16
Report of Secretary and Treasurer	17
Report of Nominating Committee	169
Reservoirs	72
Stand-Pipe for Waterworks	102
The Banquet	172
The Consumption of Water by Cities and Towns	46
The Exhibits	171
The Indirect Income of Water Supplies	95
The Sanitary Protection of Water Sheds of Rochester	18
The use of Salt Glazed Vitrified Pipe	29
The Water Supply of Tokio, Japan	49
Tunnels	120
Waterworks Accounts	129
Water Supply Treatment and Sources	8
Waterworks at Paterson, N. J., (Illustration)	27
Yearly Rental Value of Hydrants	157

EIGHTH ANNUAL MEETING

OF THE

AMERICAN WATER WORKS ASSOCIATION,

HELD AT CLEVELAND, OHIO, APRIL 17, 18 & 19, 1888.

MORNING SESSION, TUESDAY, APRIL 17, 1888.

The meeting was called to order in the Assembly Room of the Hollenden Hotel, at 10:30 o'clock, by the President, Col. J. T. Fanning, who said: Gentlemen of the American Water Works Association, the time has now arrived for the opening of our meeting, as we have been somewhat delayed, we will proceed immediately to business, and I will ask the Secretary to call the roll.

Upon the call of the roll, the following members responded:

ACTIVE.

Allen, Chas. P.....Denver, Colo.
Ayres, H. W.....Hartford, Conn.
Babcock, S. E.....Little Falls, N Y.
Brown, Calvin S.....Toledo, Ohio.
Clark, D. M.....Elyria, Ohio.
Darling, Edwin.....Pawtucket, R. I.
Decker, J. H.....Hannibal, Mo.
Denman, A. N.....Des Moines, Ia.
Diven, J. M.....Elmira, N. Y.
Dunham, H. F.....Cleveland, Ohio.
Fanning, J. T.....Minneapolis, Minn.
Frost, E. W.....Colorado Springs, Colo.
Fuller, F. L.....Boston, Mass.
Gardner, L. H.....New Orleans, La.
Gow, R. M.....Medford, Mass.
Hague, Chas. A.....New York, N. Y.
Hamilton, W. S.....Youngstown, Ohio.
Henion, Jno. W.....Minneapolis, Minn.
Holly, Frank W.....Lockport, N. Y.
Holme, Richard, Jr.....Denver, Colo.
Hooper, Thos. N.....Davenport, Ia.
Hornung, Geo.....Newport, Ky.
Jones, A. J.....New Brunswick, N. J.

Keeler, H. E.....Chicago, Ill.
Mo is, Wm.....Muscatine, Ia.
Phipps, E. H.....West Haven, Conn.
Priddy, Chas. N.....Leadville, Colo.
Richards, W. G.....Atlanta, Ga.
Ryle, Wm.....Paterson, N. J.
Stephens, Benj. F.....Flatbush, N. Y.
Troy, Jno. W.....Pierre, Dak.
Tubbs, J. Nelson.....Rochester, N. Y.
Woodruff, Timothy.....Bridgeton, N. J.

ASSOCIATE.

Adee, Fred & Co.....New York, N. Y.
Beaumont, R.....Kankakee, Ill.
Bingham & Taylor.....Buffalo, N. Y.
Chapman Valve Co.....Indian Orchard, Mass.
Clow, J. B. & Sons.....Chicago, Ill.
Columbus Water Works.....Columbus, Ohio.
Galvin Brass & Iron Works.....Detroit, Mich.
Gaskill, H. F.....Lockport, N. Y.
Hersey Meter Co.....Boston, Mass.
Kellogg, E. H. & Co.....New York, N. Y.
Lake Shore Foundry.....Cleveland, Ohio.
Ludlow Valve Mf'g Co.....Troy, N. Y.
Morgan, A. W.....Buffalo, N. Y.
Mueller, H.....Decatur, Ill.
National Meter Co.....New York, N. Y.
National Tube Works Co.....Chicago, Ill.
Payne, W. S.....Fostoria, Ohio.
Union Water Meter Co.....Worcester, Mass.
Wood, R. D., & Co.....Philadelphia, Pa.
Worthington, H. R.....New York, N. Y.
Wortley, Ted, & Co.....Kansas City, Mo.

NEW MEMBERS.

The Secretary presented applications for membership as follows:

ACTIVE.

Bement, R. C. B.....St. Paul, Minn.
Benzenberg, G. H.....Milwaukee, Wis.
Bond, Jos. A.....Wilmington, Del.
Cooke, Edward C.....Tiffin, Ohio.
Gerecke, F. W.....Chicago, Ill.
Harris, S. W.....Racine, Wis.
Harris, W. T.....Jackson, Tenn.
Judson, Chas. A.....Sandusky, Ohio.
Lakin, John T.....Rockford, Ill.
Morley, Philip.....East Liverpool, Ohio.
Neville, Thos. J.....Rochester, N. Y.
Shepperd, F. W.....New York, N. Y.
Snow, E. J.....Brooklyn, N. Y.
Taylor, John W.....Newcastle, Pa.
Wadsworth, A. R.....Farmington, Conn.
Walker, J. S.....Birmingham, Ala.
Young, John.....Geneseo, N. Y.

ASSOCIATE.

Edson, Jarvis B.....New York, N. Y.
Hall Electric Pump Co.....Plainfield, N. J.
Jewell Pure Water Co.....Chicago, Ill.
Oliphant, Wm.....Jersey City, N. J.
Richards, H. DeC.....Jersey City, N J.
Rouse & Hills Co.....Cleveland, Ohio.

It was moved and seconded that the foregoing applicants for membership be elected as read, and that the Secretary cast the ballot of the association.

Carried.

Upon their election being announced, were welcomed to membership.

THE PRESIDENT:—I observe that Mr. Darling, President of the New England Water Works Association, is present. I should be very glad to have him come forward and take a chair nearer the front. Mr. Darling is a member of our association. I suppose that most of you have met him before, and I know will be glad to see him.

MR. DARLING:—Mr. President and Gentlemen of the American Water Works Association, it affords me a great deal of gratification to be present with you to-day and to congratulate you upon your goodly number present. I desire to extend the congratulations of the New England Association, whom I have the honor to represent, and to wish you God-speed in your laudable undertaking. I believe this association is on the right road. Among those in attendance here to-day (although it is not a new place for me to be, in the meetings of this association,) I see a great many new faces, which affords me a great deal of pleasure. I hope we shall continue to grow as we have in the past, and as we have the material to work with I am satisfied that that result will be accomplished in the end. Thanking you for your attention, I accept the seat kindly proffered by your chairman. (Applause.)

MR. BURKE:—Mr. President and Members of the Association, I have an invitation from the Globe Iron Works Company for you to attend a launch at their yard at three o'clock this afternoon. They will be very glad to have you accept the invitation and honor them with your presence. The boat was constructed for the managers of the Manitoba Road and is a very fine steamer. If you will postpone your meeting this afternoon and go, I would be very glad to have you see the launch.

THE PRESIDENT:—Gentlemen, you hear the proposition that Mr. Burke presents. It is a courteous invitation and I would like to hear your views as to whether you will accept the invitation and whether you think we ought to spare the time from our business.

MR. GARDNER:—Mr. President, with due appreciation of the courtesy of the invitation extended, I move that the matter be referred to the Executive Committee for their decision and a later report. Carried.

THE SECRETARY:—I desire to offer a motion. That the Civil Engineers' Club of the City of Cleveland, together with the Water Commissioners, and all interested in the Water Department of the City of Cleveland, and any member of technical schools in the vicinity be invited to seats with us, and that the courtesies of the association be extended to them.

THE PRESIDENT:—I think the motion of our secretary is very timely, and it is with pleasure that I put the question. Carried.

THE PRESIDENT:—According to our order of business, at this time comes an address from the President, but instead of giving you any set address I will read a paper on

WATER SUPPLY TREATMENTS AND SOURCES.

NATURAL CLARIFICATIONS.

The first and highest among municipal duties is that of securing the most wholesome public water supply and thereafter faithfully protecting the same. If, charged with this duty the municipality goes to the river, the lake, or the hill-side stream in search of a pure supply, it will learn that all these waters have their sediments and solutions, and most of them have such impurities as will catch the attention of even a careless observer.

When the public eye observes, or the public receives a rumor that these impurities are flowing from its taps, there is a liability of exceedingly capricious opinion. This capriciousness over real, and more often over supposed, impurities, is one of the chief difficulties with which projectors and managers of water-supply have to contend, and out of it have grown discussions and hatreds and divisions that have almost rent communities asunder.

Sometimes the consumers of water accept a supply graciously when to do so is to endanger their community, and on the other hand lack of funds or probable profit may influence the acceptance of a pernicious source until a change is more feasible.

The waters from mountain streams among the granite hills, though unfortunately within reach of so few villages, are the purest, and are also the clearest waters, except in their floods. Then next, the waters from the gneiss, trap and other unstratified hills, and then upland lake waters are excellent in their flow; but these when gathered in resorvoirs exposed to the light, may be as prolific producers of tiny plant life as a newly fertiized lawn. We must store them in darkness and keep their temperature low or they will present a requirement for artificial clarification.

As the hill-side streams and waters of the upland lakes abrade their channels and shores and receive the drainage of the midland forests and low-land swamps, they take in mineral and organic sediments, and on reaching the lower valleys as large rivers, there has come the necessity for, in some degree, their artificial clarification to fit them for portable water supplies. For villages and towns not on the upland hills, clarification, in some form, is a result of most exalted importance.

Among the bases of such hills as furnish the best water, are found the best examples of naturally clarified waters in their clear flowing springs.

The villages and towns of the midlands and plains have to create artificial springs, in order to receive the advantages of natural clarification. This they may do in various forms of driven and steened wells, in infiltration tanks and in filtration galleries, but for reasonable success they must be in silicious sands or coarse gravels, so that the flow may be ample and the mineral impregnations slight. Large proportions of soluble minerals in the soils leads to undue hardness in the waters and excludes such soils from the availables for infiltration purposes.

The areas of water-sheds of the wells and galleries are controlling conditions, for the rainfall upon each water-shed area, less evaporation, is the true source and measure of supply. The uniformity of continuous flow of this rainfall is governed by the storage capacity of the soil and percolation to the driven wells through its water-shed sub-strata. If the gallery and sources of flow are shallow, then the water-shed must be closely scrutinized lest some organic taints be washed down in solution from the surface where the rainfall is gathered.

Three principal conditions of successful infiltration of potable waters are, first, sufficient water-shed; second pervious receiving and conducting strata; and third, insoluble storage strata. The most successful infiltrations for supplies of towns and the large villages have been into relatively long and narrow galleries, and the purities of their waters have varied according to the nature of the filtering soils.

The mineralogical conditions suggested above indicate in a general way, where infiltration supplies may be sought with a reasonable degree of success. In their most successful use, about one-tenth acre of bottom surface in the gallery has supplied 1,000,000 gallons of water, requiring a gallery, say 8 ft. wide and 540 feet long.

Granular sands offer the best possible conditions for infiltration, and are some times available in the islands and shores of lakes and streams. Without the most favorable conditions, the extent of gallery required makes infiltration unavailable to the medium sized and larger cities of the valleys.

DEEP WELL WATER SUPPLIES.

Different systems in the construction of water works, like styles in architecture, have their respective waves of popularity. Just at present driven and drilled wells are attracting much attention, and all over our land, prospectors are drilling deep for water, oil and gas.

Discussions of the "germ theory" of disease have been frequent of late, in which drinking water from surface sources is assumed to be some times a conveyor of micro-organisms which become lodged in the human system and induce various fevers and epidemic diseases. These have had much influence in leading individuals and villages to seek their water supplies, deep below the habitations of the proptophyta and protozoa, and there is a popular notion in most localities that if a well is only drilled deep enough anywhere, a flow will be the reward, as copious as when Moses smote the rock in the wilderness.

There are localities where an artesian flow of water or oil is a probability, and other localities where the financial expenditure for a test is unwarranted. An intelligent stratiographic study of any locality is the basis of a prediction whether granite, limestone, sandstone, shale or coal will be found in the sub-strata, and likewise it is the basis on which to found the prediction of the presence or absence of water or oil that will flow with sufficient volume and pressure.

An invariable condition of which a flowing well may be produced is an inclined, porous or pervious stratum overlaid, with an impervious stratum, and the pervious usually overlays an impervious stratum. To illustrate these conditions on a minute scale, take a china saucer and cover its interior with a $\frac{1}{4}$ in. depth of granular sand and then place within it another smaller saucer covering the sand. Now, if the sand between the saucers be filled and replenished with water to the brim of the inner saucer, by rain or otherwise, and a fine hole be drilled through the lower portion of the inner saucer, then an artesian flow will be the result. Substantially this condition is often found in the sandstone region, and where an extensive coarse granular stratum of stone or of gravel lies inclined between fine-grained stone or clay, and has a broad outcrop at its highest edge, a copious supply of water will be found, and the volume of water it can continuously supply will always be dependent on the replenishing rainfall supplying its higher portion of outcrop, its available water-shed.

This condition cannot be anticipated where the igneous rocks are near the surface or where the rock is fine-grained, as in limestone or slate, unless the rock is badly shattered. Portable artesian water can rarely be anticipated in the bituminous belts, now well defined in the settled portions of our continent, and usually well outlined in the geological maps of our States, and only in this latter may oil and gas reasonably be anticipated.

As with the gallery, so with the artesion supplies we find the extent of available watershed to interpose a limiting condition, and rarely can the medium and larger sized cities of the valleys find an ample deep well clarified supply by searching among the strata. These cities, in order to have clarified water, must employ some form of artificial clarification to improve available surface water supplies. We have already alluded to

the usual necessity for such clarification, but when the necesities that grow out of our physical requirements are opposed by municipal financial weakness, the weakness usually proves the stronger.

ARTIFICIAL CLARIFICATIONS.

Sedimentation, precipitation, filtration and æration of water supplies are subjects that have been ably discussed in these meetings, and some valuable papers relating to these topics are ready for presentation during this annual gathering, so that a mention in outline only, is proper at this time. As in natural clarification so in artificial, the chief objects are the removal of:

1. Mineral matters in suspension, consisting chiefly of silicious and calcareous sands, marls, loam and clay.

2. Dissolving organic matters in suspension, both vegetable and animate.

3. Live organisms, both vegetable and animal, and for a further duty the dissolution of the organic and mineral solutions in the water, including the removal of acquired color and restoration of a due proportion of oxygen.

As incident to the study of clarification of waters attention has been drawn to the forms of aquatic life that lead to the chief necessity of such treatment. We have observed that the clear mountain streams held in storage, and pure waters generally, if exposed to light and summer warmth develop certain of the fresh water algæ with rapidity, and of such plant life the desmids take most kindly to the pure water. They are harmless while thriving, but if abundant give odor and opaqueness to the water as they decay.

The oscillatoria and confervæ incline to waters with calcareous impregnation and are indicative of hardness to some extent. The bacteria are of the lowest group of algæ, and incline to waters having organic pollutions, and these are the microscopic plants we are taught most to fear. Their presence has been believed to be invariably associated with the putrefaction of decaying animal and vegetable matter and their tenacity of life is not less remarkable than that of the lowest forms of animal organization. Dr. Cohn distinguishes two classes of them present in the ferments of putrescence, a color-producing class and a disease-producing (pathogenous) class.

The term "microbes," as used in our literature of water analysis, includes both the micro-algæ and micro-fungi. The biological investigations of public water supplies includes the study of the characteristics of the microbes and of the effects they may produce on contact with life and their effects when introduced into the human system.

Among the lowest forms of animal aquatic life the spongilla has proved most offensive in the odors it gives to our natural lake and impounded waters. The tiny infusoria and polypes sometimes develop in superabundance, and in their decay make an objectionable water pollution. The pollutions most apparent to the naked eye, other than mineral sediments, are the washings of forest and field, disolving into a fibrous condition, and the pollutions harboring most dangers are the several classes of sewage in process of dissolution and in solution.

Dilution and agitation are Nature's remedies for natural pollutions, but humanity has counteracted the remedy where it

has built its gardens, factories and towns more numerous and dense as the water grows slacker along its course through the valleys to the sea.

The remedy which has been most extensively tried and most discussed in these meetings is sand filtration, and you are familiar with the construction of sand filters. Among the best surfacing materials for these are fine grained silicates of soda, the granitic sands, and with these are mixed at time granular iron and especially the magnetic carbide of iron and charcoal, and prepared silica-carbon and charcoal plates have also been used. These filters do excellent service if they are cleaned as often as excellent service demands, which is very often for a turbid water. If not duly cleaned they may clarify water for a time, in lessening degree, until the filter is so foul with intercepted matter as to finally pollute the flowing water. Uncleaned and unærated filters, public or private, are an abomination and a danger.

Sand filters for public supplies require about four-tenths of an acre of surface for each million gallons per diem. capacity, and costs from $50,000 to $80,000 per acre for original construction. In Northern cities the accumulation of anchor ice on the surface of the sand, and the ice on the surface of the water, interferes with the use of such open filters, and under favorable conditions the cost of filtration of turbid waters will not be less than $2.50 per 1,000,000 gallons of water filtered.

The water ought, if possible, to be prepared for either public or private filtration by sedimentation, if it carries much sand or coarse sediment, and by precipitation if it carries much fine clay or organic matter in suspension, mineral or organic matter in solution, or contains undue proportions of aquatic life, so that the filter may be relieved of excessive work, clogging and pollution, and may be thoroughly cleaned with ease.

Various precipitants are familiarly known and used in the processes of the arts, including salts of many of the metals. For instance: the sulphates and per-sulphates of iron, copper, manganese, zinc, alumina, potassa, lime, and the chlorides and perchlorides of iron, tin, aluminum, magnesium, calcium, etc. Hydrated aluminum chloride and alumino-ferric compounds have had large applications, and iron filings, scraps and bundles of wire have been used in the purification of water polluted with vegetable organic matter in process of dissolution. Alum, lime and iron have long been used for precipitants by families whose household supplies of water came from the clay carrying rivers or the dark stained upland lakes. The sulphates of metal should, however, be used cautiously where they are liable to contact with organic dissolutions, as they may be converted into soluble sulphides and disengage sulphuretted hydrogen.

For the water supply of a large city natural sedimentation, by rest of the water in settling basins, is a slow process, excepting for the coarse sands and heavier sediments and requires large and costly basins in which to give the water six to twelve days rest before it is passed into the distribution system. With the proper and continuous use of precipitants as much may be accomplished in the same number of hours with great saving in cost of settling basins. Some of the precipitants have such affinities for organic matters in dissolution, and clays in suspension, that they almost instantly unite with them in coagulating floccu-

lent masses, and are so concentrated that they have sufficient specific gravity to promptly start them journeying downward to the basin floor. In this movement of the flocculent material clarifying the water, the micro-organisms in the midst of the organic pollutions are largely caught and borne downward. In the coagulations are caught much of the impalpably fine organic matter, and also the microscopic plants that give color or opaqueness or turbidness to the water. At the same time the dissolving organic matters that are thrown down to await the periodical cleaning of the basin floor are rendered less soluble by their contact with the metallic salts, which, with exclusion from the air, hinders their further dissolution. The basin floors ought to have frequent and thorough cleanings. Those pollutions in the water that incline to resist precipitations are common salt, urea, ammoniacal salts, salts of the alkaline earths, oils and refuse similar to that from gas works. As nitrates and nitrites are not fully controlled by the precipitants economically available, it is evident that precipitation is not a permanent guarantee against later putrefaction in the water if it is afterwards exposed to light and warmth of the summer sun, but the tendency is lessened by reduction of its cause. Limey waters are alkaline and there is more tendency to active putrefaction in alkaline than in neutral or acidulated waters. Then we are to observe that the salts of iron, if used in excess, give colors to the water ranging from greenish yellow to black; for instance, contact of iron with sulphur gives a very dark brown tint.

For water supply clarification purposes, solutions of iron, aluminum and calcium are the precipitants most economically and commercially available, and they are used alone or in varied combinations according to the character of the sediments and pollutions to be acted upon. Very small proportions comparatively, are effective and the precipitants themselves are so completely carried down with the precipitated matters that bare traces of the former remain in solution in the water.

Precipitation is an intermediate treatment between the more common processes of sedimentation and filtration, and it reduces materially the time and cost of unaided settlement, and area of settling basins. The precipitants are easily introduced, for they may flow from the faucets of one or more small tanks placed above the inlet stream of the settling basin, and thus be intimately intermingled with the waters.

In preparing an iron solution for clarifying the muddy water of the Mississippi, at New Orleans, our honored ex-President has treated red hematite iron ore with hydro chloric acid, bringing it to 1.5 specific gravity, and his experiments showed that one part in 20,000 clarified the muddiest water of the river, and neither hardened the water or left any trace of iron therein.

In every case where filtration is desirable, preliminary preparation by precipitation is important, and in very many cases where sand filtration on the older system is, for financial or other reasons impossible, precipitation will greatly improve the water supply, and private filters on the services of such as can afford them can complete the process in that portion of their waters that are devoted to culinary and driking purposes.

With precipitation most waters will be fully fitted to enter the distribution pipes, and in the filtration that follows as a separate treatment the filters will be greatly relieved of those

organic matters that soonest clog and pollute them, and the trouble of such frequent cleanings as public or private filters must have, in any event, will be lessened, and the thoroughness with which they may be cleaned will be much enhanced. After precipitation or filtration the waters should be kept well covered and it is advisable that they shall not be kept in storage long enough for the slight amount of remaining organic matters to again reach a condition approaching objectionable dissolution.

Aeration, which will restore to the water an abundance of oxygen, is a most excellent treatment and antiseptic after precipitation and filtration. This is simply accomplished by forcing air into the pumping main or letting it be drawn into the suction chamber of the pump, or into the supply main from the reservoir.

PROTECTION OF SOURCES OF WATER SUPPLY.

Glancing over a map of the water courses of our country, we observe that the towns and cities designated thereon are generally on the shores of those streams where water-power encourages their growth or facilities for commerce increase their wealth. The streams are the natural sewage channels of their water-sheds, and the water supplies taken therefrom suffer according to the densities of the population, and the extensiveness of the manufactures and agricultural productions along their courses. To prevent the establishment of mills, with their accompanying villages and gardens, along the rivers, will, to some extent, interfere with local and national prosperities, and to entirely prevent the sewage of the upper villages from flowing down to the cities of the lowlands will, in a measure, interfere with natural laws;

We are not adequately handling our water supplies by simply filtering out such pollutions as may chance to come down to us, but ought to begin our purifications by attacking the pollutions themselves where they originate and providing that they shall, so far as possible, be first spread broadly on the lands, and there precipitated and clarified by Nature's laboratory process.

Except in the mining and bituminous districts and alkali plains, we need rarely fear the mineral impregnations that nature sends down in our water supplies. It is the vegetable organic, and especially the sewage organic matters in dissolution that we have most to fear, and these multiply as the populations increase. It is in the midst of these that the disease inducing germs chiefly generate. The desmids and bacteria of the purer waters, though frequently abundant, are not proved, nor yet fairly accused, of endangering human constitutions, though absorbed through the medium of water supply.

The residents of local water sheds have their duties, each for their area to meet and handle this phase of the problem. The United States has now a total population of about 60,000,000 people. Our past rates of decennial gain have been:

1840	to	1850—35.81	per cent.
1850	"	1860—35.57	"
1860	"	1870—22.62	"
1870	"	1880—30.07	"

The increase is most rapid in the towns and cities where the systems of water supply must be public in their character.

Eighty per cent. of the population of the State of Massachusetts, for instance, is already so grouped as to be provided with public water supplies.

The rapid gain in population, the concentration of the people in towns, the increase in number of towns and in new water supply systems, all significantly suggest a united action looking to the matter of protections of the sources of additional water supplies for existing towns, and of new supplies for future towns. This is a question that seems to loom up before us as though it might soon assume even national importance, and may in the early future tax the highest resources of statemanship and most exalted wisdom. The matter is worthy the earnest consideration of the American Water Works Association.

MR. DUNHAM:—I would like to say that Mr. Hills, of The Rouse and Hills Co., kindly extends an invitation to the members of the Association to visit their factory at Lorain. They are manufacturers of brass goods, and have, I believe, one of the best shops in the country.

THE PRESIDENT:—Mr. Hills has extended an invitation to the members of the Association to visit their works. If it is your pleasure, it will be referred to the executive committee, the same as the other.

Said invitation was then referred as indicated.

THE PRESIDENT:—The next matter in order should be the report of the executive committee. I am informed, however, that the committee are not ready, it will therefore lay over until our afternoon gathering.

Adjourned.

AFTERNOON SESSION, TUESDAY, APRIL 17TH, 1888.

Meeting called to order by President Fanning at 2:30 o'clock.

THE PRESIDENT:—We have with us the City Engineer of this city, Mr. W. P. Rice, whom I now introduce to you and who would like to speak to you a few words.

MR. RICE:—I desire to say a few words in behalf of the Engineers Department. I wish to extend a cordial invitation to you to visit any of the public works now going on in charge of the Department. I think it will be of interest to the members. I will be glad to conform to any arrangement that may meet the approval of your committee of arrangements.

MR. GARDNER:—I move that the invitation be referred to the committee of arrangements.

Adopted.

THE PRESIDENT:—The next order of business will be the report of the Executive Committee, which will be presented by Mr. J. M. Diven, Vice-President.

To the Members of the American Water Works Association:

GENTLEMEN.—Your Executive Committee would respectfully report:

That they have fixed the salary of the Secretary and Treasurer at $250 for the past year, and have authorized him to draw warrant for that amount.

It is with profound sorrow and regret that we note the death of two of our oldest and most valued members; Messrs. John Ryle, of Paterson, N. J. and W. C. Stripe, of Keokuk, Iowa. We would recommend that the Secretary be instructed to prepare suitable obituary notices and publish them with the proceedings of this meeting, and that copies be furnished the families of the deceased.

In view of the fact that to the latter of our deceased members, Mr. W. C. Stripe, is largely due the credit of the organization of this Association, that he was practically the father of it, we would recommend that a suitable portrait of him be made and inserted in the proceedings.

We recommend that hereafter the proceedings be furnished gratuitously only to the members of the Association, the technical press and schools, and to such kindred associations as may desire to exchange, and that to all others a uniform charge of fifty cents per copy be made.

Your committee has considered the courteous invitation extended by the Globe Iron Works to witness the launch of an iron steamer from their yard this afternoon at three o'clock, and while we agree that it would be both pleasant and profitable to witness the launch, our time is so limited that we beg leave to acknowledge the courtesy with our hearty thanks and to express our sincere regret at being compelled to decline it.

We have also considered an invitation from the Lake Shore Foundry to visit their works and recommend its acceptance.

We recommend that Friday be set apart for the purpose of visiting such places of interest as may be arranged for, and that the matter of arranging therefor be left with the Committee of Arrangements and Reception, to whom all invitations of this character be referred.

Respectfully submitted.

J. T. FANNING, Prest. for Ex. Com.

Cleveland, Ohio, April 17th, 1888.

On motion the report was adopted as read.

MR. DIVEN: I move that we meet here at eight o'clock Friday morning for the purpose of visiting the various points of interest that may be arranged for by the committee.

The motion was adopted by a standing vote.

THE PRESIDENT: The next thing in order is the report of the Finance Committee. Mr. Denman is Chairman of that committee and will please report.

MR. DENMAN: I report we have examined the Secretary's accounts and find them all correct, and would state the detailed report of the Secretary will comprise what the Finance Committee would say if they were to make a written report.

THE PRESIDENT: We will now hear the report of the Secretary and Treasurer.

REPORT OF SECRETARY AND TREASURER.

To the Officers and Members of the American Water Works Association:

GENTLEMEN:—I have the honor to submit herewith my eighth annual report as Secretary and Treasurer of the Association.

Since the presentation of my last report the Association has gained 1 Honorary, 44 Active and 5 Associate members; and has lost, by death 3, 2 Active, W. C. Stripe, of Keokuk, Ia., and John Ryle, of Paterson, N. J., and 1 Associate member, James Flower, of Detroit. Mich.; by resignation 4—3 Active and 1 Associate, leaving an actual net gain of 43 members. There are now enrolled, 1 Honorary, 220 Active and 54 Associate, a total of 275 members.

CASH STATEMENT.

Balance on hand last repot		$230 00
Rec'd from Admission Fees	$270 00	
" " Annual Dues	579 00	
" " Y. Nakjima (contribution)	5 00	
" " Sales of Proceedings	7 90	
" " " " Denman Papers	3 35	865 25
Total from all sources		$1095 25
Disbursements:		
Paid Warrant 32, in favor M. P. Yocum, Stenographic Report		$ 47 55
Paid Warrant 33, in favor Standard Ptg. Co., Proceedings and Stationery		283 30
Paid Warrant 34, in favor Standard P. Co., Notices and Badges		40 10
Paid Warrant 35, in favor J. T. Fanning, Prest., Ptg. & Postage		234 90
Paid Warrant 36, in favor J. H. Decker, Secy., Office Ex. and Postage		67 85
Paid Warrant 37, in favor J. H. Decker, Salary		250 00
Balance Cash on hand		171 55
		$1095 25

With hearty and sincere thanks to my fellow officers and members for the many courtesies extended and the assistance rendered, which has served largely to reduce the cares and duties incidental to the office, this is

Respectfully submitted.

J. H. DECKER,
SECRETARY & TREASURER.

Cleveland, Ohio, April 17th, 1888.

On motion the report was accepted as read.

THE PRESIDENT: There being no further routine business we will now hear Mr. J. Nelson Tubbs, of Rochester, N. Y.

MR. TUBBS: When your President invited me to read a paper I had in contemplation the preparation of a paper covering the general progress of the sanitary protection of water sheds, but on getting into the matter a little I found the time it would take prevented my undertaking it. I have, therefore, confined myself and paper exclusively to "The Sanitary Protection of Water Sheds of Rochester," believing that the members of this association are intensely practical in their work and like to hear of things practically accomplished, I have prepared some printed copies and the paper is very short.

METHODS ADOPTED FOR THE SANITARY PROTECTION OF THE WATER SHED WHICH FURNISHES A SUPPLY OF WATER FOR DOMESTIC PURPOSES TO THE CITY OF ROCHESTER, N. Y.

The water for a domestic supply for the City of Rochester, N. Y., is obtained from a natural lake, situate in the county of Livingston, about thirty miles southerly from and at an elevation of 388 feet above said city. The Indian name for this lake is O-neh-da, or, in English, Hemlock.

The lake is about seven miles long and five-eighths of a mile wide. It occupies the northern extremity of a deep, narrow valley, which is fifteen miles long. In the southern part of the valley is situated the village of Springwater, having a population of about 600. The shores of the lake are bluff and steep, rising to a height of from 300 to 500 feet, and mostly covered with a growth of timber.

The basin of the lake is deeply excavated in the formation known as the Marcellus Shale, lying above the limestone rock of that region.

In the Springwater valley, south of the lake and on the summit of the bluffs forming the boundary of the basin, are a considerable number of farms devoted to the usual purposes of agriculture.

About the time at which operations were commenced to utilize Hemlock Lake as a source of water supply for the city, the attention of our own citizens, as well as those of surrounding cities and towns, was attracted to the lake as a desirable point for summer residences.

The wildness of the scenery, the purity of the water, the healthfulness of the situation and the general beauty of the surroundings, together with its elevation of 900 feet above the sea at surface of lake, with the slope of the hills rising to 1,400 feet, has gradually attracted a considerable summer population. At this date there are in use about 100 cottages and several hotels or summer boarding houses, and the summer population, including transient visitors, amount to from 500 to 700 persons.

The necessity for the efficient sanitary protection of this water shed was self evident. Obviously the ideal method would be the purchase of the lake and its whole water shed and the removal therefrom of every habitation or shelter for man or domestic animal, including all farm and village constructions and improvements, and to restore the whole area to a state of natural wildness and savagery.

The following objections to this plan seemed practically insurmountable

1st. The municipality, with a present population of 130,000, has already expended about $4,000,000 in the construction and extension of its water works.

2d. The additional cost involved in the purchase of the whole water shed of forty-two square miles would prove enormously burdensome.

3d. The purchase of the valuable improvements and constructions in the village of Springwater would further add to this vast cost.

4th. The large annual taxation on so large a freehold would prove an onerous burden, as it could hardly be expected that the courts would so liberally construe the laws as to exempt it from taxation when acquired solely for the purpose named.

5th. It has been held in our State Courts that Hemlock Lake is a navigable body of water, and therefore open to be navigated at will by any and all citizens of the State, for the purpose of pleasure or profit, no matter who might be the owners of the adjacent lands, so that access to the lake could be denied to none.

6th. The land under the water of t e lake is claimed by the Poultney estate, a foreign owner, and it is doubtful whether its title could be adversely extinguished for such a purpose under our laws.

From the foregoing it will be seen also that a purchase of a strip of land a few hundred feet wide around the margin of the lake would not accomplish the desired purpose.

The plan for the accomplishment of this purpose, which was finally adopted, may be briefly stated as follows:

The Legislature of the State was induced to pass a general act entitled "An act to confer upon the State Board of Health power to protect from contamination, by suitable regulations, the water supplies of the State and their sources."

By section 1 of said act "The State Board of Health is authorized and empowed to make rules and regulations for pro-

tecting from contamination any and all public supplies of potable waters and their sources within the State," &c.

Section 3 provides as follows: "The officer or board having by law the management and control of the potable water supply of any municipality, in all cases where said municipality derives its water supply in whole or in part from any subsoil waters, springs, streams, lakes, ponds, reservoirs or other waters, concerning which the State Board of Health shall make any rule or regulation, is hereby authorized and empowered to make such inspection of the sources of said water supply as said officer or board may deem advisable, to secure the said water supply from any defilement, and to ascertain whether or not the rules and regulations made by the State Board of Health are complied with."

Section 4 provides that in case such inspection discloses the violation of any of said rules, the officer or board shall serve a notice on the party offending, specifying the rule or regulation claimed to have been violated. If the person so served does not immediately comply with the regulation, the officer or board shall notify the State Board of Health, which board shall examine into the matter, and if a violation is found, the local board of health shall be ordered to convene and enforce the regulation.

Section 5 provides that in case the local board of health fails to enforce the order within ten days after notification, then the corporation furnishing the water supply, or the municipality deriving its water supply from the waters for the sanitary protection of which such rules have been made, is authorized and empowered to maintain an action in a court of record against the person violating the rules for the recovery of the penalty therein provided.

Section 6 provides that "Every person who shall wilfully violate or refuse to obey any rule or regulation made and published by the State Board of Health and approved pursuant to the provisions of this act, shall be guilty of a misdemeanor, and on conviction thereof shall be subject to a fine or imprisonment, or both, at the discretion of the court, such fine not to exceed $300, nor such imprisonment six months. But the recovery of a penalty in a civil action, as provided in section 5 of this act and criminal prosecution and conviction under the provisions of this section, shall not be had for the same offense."

Section 7 provides that in case the rules require the providing of some public means of removal or purification of sewage the municipality or corporation owning the water supply shall pay the cost thereof.

Under this act the State Board of Health was requested to and did prepare and establish rules and regulations for the sanitary protection of the waters of Hemlock Lake, the public water supply of the City of Rochester.

These regulations provide, in substance, that privies, pig pens and barnyards shall not be located over or adjacent to any stream, spring, or dry water course where the contents thereof can reach the same. That any privy situated within fifty feet of any spring, stream or dry water course, or ravine, shall be constructed without a vault, and shall have under the seats water tight receptacles for night soil, which shall be frequently removed, emptied, cleaned and returned, and the contents buried

in the earth in such a manner that they cannot by any possibility reach any water course or permanent level of subsoil water.

No manufacturing waste is allowed to be discharged or drained into any spring, stream or dry water course on said water shed.

The same restriction applies to the depositing of dead animals, birds, fish, decayed fruit, leaves, sawdust, roots, branches or trunks of trees in any spring, dry water course, or into the lake itself. The washing of sheep or other animals in the lake or any of its tributaries is also prohibited.

The provisions relating to houses, cottages, tenements, tents and picnic grounds within 200 feet of the shores of the lake may be summarized as follows: Each is to be furnished with at least one privy set upon the surface of the ground, without a vault, and so constructed that metallic pails, fifteen inches high by fourteen inches in diameter, can be placed under the seats and easily removed with their contents.

The occupants are required daily to add dry loam in small quantities, as a deodorizer and absorbent. It is made the duty of the occupant also, to provide a receptacle for dry garbage and to carefully place the same therein. All slop or wash water to be scattered upon the surface of the soil at a distance from the lake, or any ravine or water course and the points at which said slops are deposited to be frequently changed.

Animal manures from stables are required to be carefully deposited in tight covered receptacles and the contents thereof to be frequently removed.

The City of Rochester is required to furnish a sufficient number of metallic pails for the use of each necessary privy within 200 feet of the lake and is required to remove, empty, cleanse and disinfect the same as often as is necessary. When a full pail is removed an empty one is to be supplied in its place. The pails during removal are to be provided with air-tight covers, so that no odor shall escape.

The contents of the pails, together with the dry garbage, is required to be removed by the city to a point below the foot of the lake and there buried.

As soon as possible after these rules were ordained and sanctioned by the County Judge, the city commenced operations thereunder, and has continued the same since that date, a period of three years.

In practice, the night soil and garbage is collected and removed to the foot of the lake by means of a broad, flat bottomed steamboat, the collections being usually made in the early morning.

From the steamboat landing the night soil and garbage has heretofore been transported on wagons to the dumping ground, which is a plat of ground owned by the city in a retired location 1,800 feet below the foot of the lake. It is intended soon to construct a tramway between these points, so that the transportation may be done on a platform car, the cans being unloaded directly on the car.

The treatment of the night soil and the garbage, on its arrival, is as follows: Narrow trenches are excavated, care being taken that the permanent level of subsoil water shall not be reached, and the contents of the pails are deposited therein in thin layers. It is then immediately covered with dry loam to

a depth of about six inches. This process is repeated day by day until the trench is nearly filled, when the balance is rounded up with earth. A measurement of the location of these trenches is made and recorded, the surface cultivated and cropped, and after a suitable period the same land may be again used for a like purpose. A trench 500 feet in length has proved entirely sufficient for a single year's operation up to the present time, and as these trenches need not be more than three feet apart, it will be seen that but a small area need be provided for the purpose.

The cans, as fast as they are emptied, are taken to the sanitary building, which is provided with an elevated tank filled with a solution of copperas, and also all other necessary appliances for washing, cleansing, deodorizing and drying the cans. The cans are of heavy galvanized iron, and are thoroughly coated, inside and outside, with a coating of black asphalt varnish. In the cleansing of the cans, if found necessary, other and more active deodorizing and disinfecting agents are employed.

The process has been so conducted for the past three years that all local prejudice has subsided and all fears as to possible offensive odors in the neighborhood allayed. In the sanitary building and about the grounds no offensive odors are discernable, although during the past year the contents of nearly 6,000 cans were thus removed and treated.

The results that have been accomplished thus far may be briefly stated :

A great proportion of the residents about the lake have become enthused with the idea of keeping their grounds in the neatest possible condition and in maintaining the sanitary purity of the water up to the highest standard. Underbrush, logs, limbs of trees and decaying vegetable growths are no longer thrown into the lake, nor allowed to litter the shores, but are carefully collected and burned. Privies, pig-pens, &c., away from the lake, but on the water shed, have been removed from streams, ravines and dry water courses and placed under such sanitary regulations and espionage as to render them unobjectionable. The local boards of health have become interested in these questions and their co-operation secured. Animals which die upon the water shed, and decayed putrescible matter of all kinds are no longer discharged into the nearest ravine, but are buried in the ground a distance therefrom. And finally, all night soil and dry garbage produced about the lake is collected and buried a long distance below the lake.

The limits of this paper will not allow me to enter into further details. I have in the briefest way attempted to outline the results of an experiment in the sanitary protection of a large water shed under unusually difficult conditions.

This has been done with the knowledge on my part, derived from personal observation and from conversation and correspondence with the officers in charge of water works in various parts of the country, that there is an imminent necessity for the sanitary superintendence and protection of many water sheds all over the continent. The plan herein briefly described, or one somewhat similar, may and probably should, with proper modifications to meet varying conditions, be applied to many of the sources of the supply of potable water in this country.

When judiciously adapted and applied, it can be operated at comparatively small expense, and will add immensely to the sanitary safety of the water supply.

Allow me, in conclusion, to suggest that this plan of disposing of night soil and other putrescible matter, is nature's own simple, effective and yet most wonderful method, and that the nearer our methods coincide with her beneficent and wonderful processes the more surely will human effort be crowned with success.

The members of this society, perhaps better than any other class of men, have knowledge of the fearful rapidity with which the natural water courses of the country are being fouled and the waters rendered unfit for potable or manufacturing uses, as well as made potent factors in the dissemination of zymotic diseases by the general discharge of the sewage of towns and cities into the nearest streams. The result of this practice is that not only the large cities, but even small towns, are required to seek remote and expensive sources of water supply, when abundant and never failing supplies of water are flowing through or near their corporate limits, originally of unexceptionable purity, but now become the sewage carriers of every city and village along their course.

As populations multiply and the demand for pure potable water increases, shall we not be compelled to abandon this pernicious system and return to and copy nature's processes for rendering putrescible substances not only innocuous, but beneficent, by employment of the wonderful chemical and assimilating properties and possibilities of our Mother Earth?

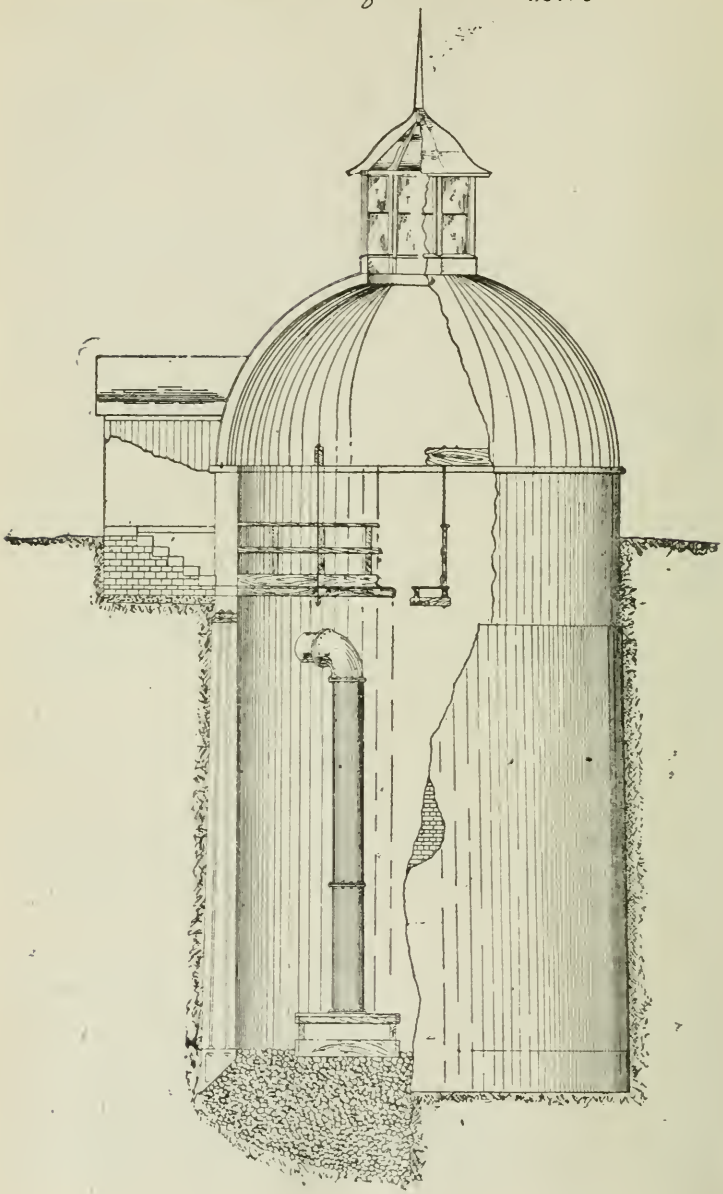
THE PRESIDENT:—Mr. Tubbs has selected a subject that is intensely interesting to many of us I presume. Perhaps some of you gentlemen would like to ask him some questions and discuss his opinions?

MR. DENMAN:—The question now comes to me what does Rochester do with her sewage?

THE PRESIDENT:—Will Mr. Tubbs please inform us, and give us also some description of the persons about the Lake whom you have taken care of in connection with the matter; the length of the Lake from shore to shore. I think we would be glad to know more definitely about this.

MR. TUBBS:—As to what is now done with the sewage, it is discharged out onto farming lands in the country. Rochester has no definite plan of sewerage I am sorry to say. It is moving in this direction. A competent engineer is now engaged and for six months or more has been at work. The gentleman does not have a general plan, or I should say I am not in his confidence to enable me to say what he will recommend, but I suppose it is some combination of discharge sewers. We have a river running through the center of our city into which

Plan of Well for
Kalamazoo Water Works



some of our sewers empty, and during the dry weather becomes highly offensive, but when there is water enough to properly carry it, it passes out of the mouth of the river six or seven miles. We have now an extensive summer resort where thousands of our people go every day to enjoy themselves on the river, so it will be impossible to discharge this sewage into the river any longer; it is that which compels this action. We have decided on no system as yet, but we are moving towards a comprehensive one.

Now, as to the disposal of the people about Hemlock Lake. It is about seven miles long. There is a bluff, or rather broken points running out to a level plateau. Along this whole plateau are cottages, sometimes in clusters of half a dozen, so that we practically extend from the foot to the head of the Lake; three miles above is Springwater with a population of about six hundred. These people when they first went there from the city and commenced taking this water found the utmost carelessness prevailing as far as the inhabitants were concerned, dead animals, hen-houses, privies, all put over the water course. All that has been changed under the operation of this rule which I have referred to.

THE PRESIDENT:—I would like to inquire if there are summer resorts and excursions on this Lake?

MR. TUBBS:—Yes, sir, from three to five small steamers ply to and from the picnic grounds and for use of pleasure parties. Under our control we have a steamboat. We have heretofore let out by contract the hauling of the night-soil by steamboat, under the control of a man in the employ of the city. This year we have constructed, or are about constructing a steamboat and dryer and all will be done by the city employes.

This steamboat will be manned by the city and owned by the city. The men will go about and see that everything is done properly. Tne sewage inspector will pass over this water-shed constantly looking after its condition, and of things outside of the Lake itself.

THE PRESIDENT:—Does anyone wish to remark further or to ask any further questions?

MR. DENMAN:—This question I consider of the utmost importance. It is easy enough to protect our own water and send our filth down to our neighbor. I am not charging Mr. Tubbs with this. I presume, however, the same care is not exercised in the protection of the whole

Genesee River as it is in Hemlock Lake. In other words it is not exercised for the people below as it is for the people in Rochester. Unless there has been a change, a radical change there in a few years, such is the case, and it arises I suppose out of the very nature of the case. It is not easy to control a large city like Rochester in these matters.

I have recently been at Evanston, Ills. I said to the people: "Where do you get your water?" "From the Lake," they said. "Where do you run the sewage?" "Right into the Lake." "There is a crib a very short distance out in the Lake, don't you get the return of all this?" They replied, "No, sir, because we know that the current always sets down towards Chicago." That is always the way up there; simply get the filth from your own door yard. Everybody is familiar with the City of Chicago in that respect. We have a representative from there, I believe, or I possibly would not express myself so freely. I have been greatly benefitted in this sanitary matter, in the disposition of the contents of the privies, by the reading of a newspaper which is published, *The Sanitary Era*, and for the first time in making some improvements about my house I tried the plan that they had published by the using of earth in the closet, very much upon the plan that Mr. Tubbs has spoken of, in using pails of sand, but the tub put in the privy was large enough for a horse to draw.

Now, I want to say to the gentlemen here that have been troubled with an old privy—and every homestead almost has such a thing—try that; give a fair test and use it freely, and leave it until the proper time comes and you will be astonished at the results. You will never dig another hole as long as you live; you will never do without a tub as long as you live.

Mr. Diven:—I would like to ask Mr. Tubbs how he controls these people on the stream that are out of the city? I did not hear your paper.

Mr. Tubbs:—We had a general Act passed; perhaps I might say that I drew this law very largely. It is a general act covering the water-sheds in the State of New York, and simply on application the State Board of Health are authorized to make rules and regulations covering water-sheds.

Mr. Diven:—I would like to ask Mr. Tubbs what is the actual annual cost of this sanitary process?

Mr. Tubbs:—Heretofore it has cost Fifteen Hundred Dollars per year, but we have been adding to our plant all

the time; perhaps now Nineteen Hundred Dollars. We are now constructing a steamboat to run on the Lake, costing perhaps Five Thousand Dollars. That is for the plant, though. I think that the actual operating expenses would be from Twelve to Fifteen Hundred Dollars per year.

MR. DUNHAM:—I would like to ask if the twelve or fifteen hundred dollars includes the amounts paid for covering the trenches—everything?

MR. TUBBS:—Yes, sir.

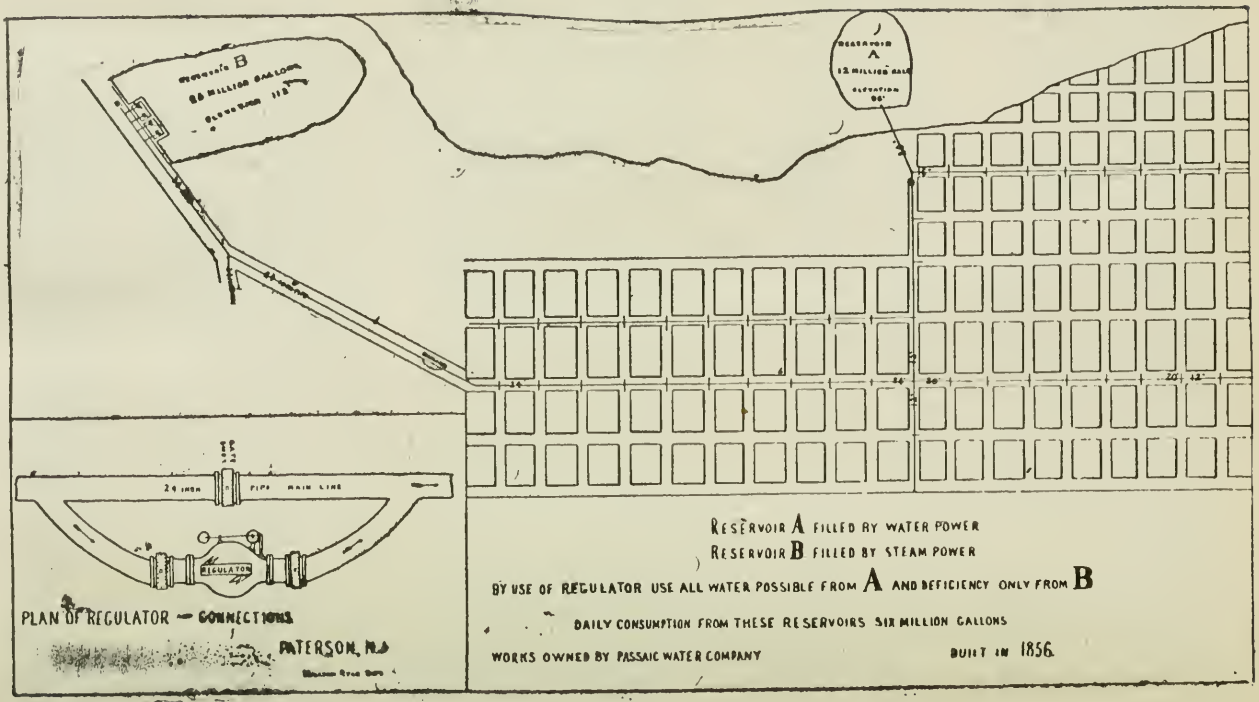
THE PRESIDENT:—Will anyone remark further on this subject?

MR. TUBBS:—I wish to say I heartily concur with the gentleman's remarks (Mr. Denman), when he said we did not have very much respect for our neighbors; that is true.

MR. DENMAN:—I did not say that.

MR. TUBBS:—It is a truth, nevertheless, which applies to Rochester as well as anywhere else. I do insist that any village, any town desiring to avail itself of this General Act may do so, and if we are fouling this water on the water-shed, the Board of Health have the power to make us abandon this project. I shall recommend and hope that you may protect your water by legislation in some such way in the different States you represent. If you can induce the Legislature to pass a similar law, you may protect your water-shed in a similar way. Some other officer or board may perform the duties assigned to our State Board of Health.

MR. DARLING:—I suppose the New England way would be the only way to protect your water. I suppose you never waste here; don't have to make any protection, but I found that the question extended all over the country and coming here I find you have the same disease that we have in New England. It is only the beginning of the greatest question we have in this country. Fifty years from now I predict that this will be one of the greatest questions that will be contended with in this country; the question of pure water. The study of adulteration of the lakes and large streams is one of the great questions of the coming time, and I believe it is the duty of ourselves as Superintendents of Water Works to try the projects, obtain the best results


RESERVOIR B
88 MILLION GALLONS
RESERVOIR A
12 MILLION GALS
24 INCH PIPE MAIN LINE
REGULATOR
PLAN OF REGULATOR — CONNECTIONS
PATERSON, N.J.
RESERVOIR A FILLED BY WATER POWER
RESERVOIR B FILLED BY STEAM POWER
BY USE OF REGULATOR USE ALL WATER POSSIBLE FROM A AND DEFICIENCY ONLY FROM B
DAILY CONSUMPTION FROM THESE RESERVOIRS SIX MILLION GALLONS
WORKS OWNED BY PASSAIC WATER COMPANY
BUILT IN 1856.

and begin it at the present time. I think we should look ahead when somebody that follows us will provide for that time.

THE PRESIDENT:—Several of our States have taken legislative action in regard to their water supply, and Massachusetts has taken more pains than any other State. It has a Commissioner to whom all matters are reported. Each of the towns that have a system of sewerage have to report to him, and if any nuisances they are brought to this Commissioner. If we have any member here from Massachusetts that could give us any information on that subject we shall be glad of it.

MR. DARLING:—While I am not from that State, that question, of course, has been seen in the working of our New England Association. Every manager of water works is required to furnish samples of the water that they use in their works to these Commissioners and the analysis is given, and we expect soon to get a final report in regard to it. They have, as you say, probably taken more pains than any other State and it has laws more stringent than others and the result will be very beneficial. There can be no doubt about that.

MR. DUNHAM:—I might add to what Mr. Darling has just stated. In sending out for samples of water to all superintendents they send not only once or twice a year, but every month, for the past year or so they have been sending out bottles requesting their return for the analysis. They have an appropriation of about thirty thousand dollars for that purpose.

THE PRESIDENT:—If no one else wishes to speak further on this question, the next on our regular programme will be a paper,—"The use of Salt Glazed Vitrified Pipe," by our brother Mr. S. E. Babcock.

THE USE OF SALT GLAZED VITRIFIED PIPE IN WATER WORKS CONDUITS.

It having been my lot to construct two quite extensive systems of gravity water works within the last six years, one at Amsterdam, New York, costing $285,000, and the other at Little Falls, New York, on which I am now engaged, costing $300,000, and in both cases the source of supply being so far distant that the use of cast iron pipes for conduits would have rendered the construction on the gravity plan almost practically prohibitory, as the additional cost would have placed too heavy a burden

on the tax-payers—at least they would have fancied so—my attention was called to the use of salt-glazed vitrified pipe as a substitute for iron; as also in rebuilding the conduit at Johnstown, N. Y., which was done during the time stated. In each case I have successfully constructed the conduit of vitrified pipe, and all of them, to this date, have not required one dollar's repairs, but are actually in the same condition as when laid, all having been in constant use from date of completion.

I have, therefore, thought that a proper description of the method of construction might be of service to some of the members of this association, should they be called upon to design a conduit in similar localities.

I will first give a brief description of the alignment and grades of the Amsterdam and the Little Falls conduits.

DESCRIPTION OF AMSTERDAM CONDUIT.

The water supply at Amsterdam is six miles distant and consists of three small mountain streams which I successfully diverted by vitrified pipe conduits and open channels into one. From this point I brought them across the country to the channel of a summer dry stream, upon which, at a point near the city, I built a combined storage and distribution reservoir. The three mountain streams were known as the McQueen and Rogers streams, and the dry stream as Bunn creek. There are two intervening ridges, or divides, between McQueen and Bunn creeks, necessitating heavy cutting to divert the water.

McQueen creek is dammed by a substantial masonry structure at a point just below the junction with the West Branch, the dam being 4 feet high; the channel of McQueen creek was widened and deepened for about 1,000 feet back; a new open channel or reservoir was excavated in direction of line to Bunn creek for about 800 feet, and until the excavation represented a cut of seven feet, to allow a sufficient depth of soil to cover the conduit and protect the same from frosts. At this point of termination of open channel, a substantial masonry inlet-chamber was designed and constructed, having suitable iron racks and fine screens, with bulkhead gate to shut down the water. From this point a vitrified salt-glazed pipe conduit 18 inches in internal diameter, has been laid to a suitable point to empty the water of Rogers, West Branch and McQueen creeks into Bunn creek. The pipe is of the pattern known as the hub and spigot, and is laid with Portland cement joints. The conduit is laid upon the true hydraulic grade line, excepting two or three points of depression, where it has been necessary to depress from one to two feet to admit of sufficient covering of soil over the pipe without changing or embanking up above the original surface of the ground. The conduit is laid to a grade with a total fall of 18 14-100 feet for 10361 feet. From this point the surface of the ground is precipitous in direction of Bunn creek, having passed now through the second divide, and a twelve-inch vitrified conduit is laid down to the channel of Bunn creek with a fall of 38 feet in 1,000 feet. The conduit has a capacity, when running full, of 2,851,300 gallons per diem, being in excess of the amount which may be expected from the Rogers, West Branch and McQueen creeks. Rogers creek is dammed up by a similar masonry structure four feet high; the water is then diverted and

carried easterly in an open channel through about 1,000 feet of low undulating ground to the west edge of a road. At this point a masonry inlet-chamber, similar to the one on McQueen creek, is constructed, and the water is passed through a 15-inch vitrified salt-glazed pipe conduit 1,500 feet long, emptying into an open water channel of the West Branch. The water of Rogers creek then passes down the channel of the West Branch, and both empty into McQueen creek at a point above the dam upon the same. From the end of vitrified pipe conduit on Bunn creek, the water flows in the open channel of Bunn creek two miles to the storage and distribution reservoir of 100,000,000 gallons capacity.

DESCRIPTION OF LITTLE FALLS CONDUIT.

The conduit at Little Falls is a much more elaborate affair. The water supply is a mountain stream known as Beaver creek. It lies due north from the village of Little Falls, and is distant about eleven miles by road from Main street or center of the village.

Beaver, as well as Spruce creek, into which it empties near the point of diversion, is a tributary of East Canada creek: the line of Beaver creek runs about due east. The ground lying between Beaver and Spruce creeks and Little Falls is depressed by two streams, Gillet and Cathaticane, or Crum creek, both running southeasterly, Gillett creek emptying into East Canada, and Cathaticane, or Crum creek, into the Mohawk river, and dividing the intervening ground about equally into four sections, or two divides and two basins or depressions.

I have utilized vitrified salt-glazed stone-ware pipe wherever I could locate the lines to a hydraulic grade line, or line of no pressure, and in the two depressions or valleys where the conduit is under pressure, substituted cast iron pipe, crossing the same up to the ground called for, by hydraulic grade line of no pressure, produced.

Beaver creek is dammed by a substantial masonry structure at the point of divergence. The dam has a spill-way 50 feet wide and floods 0.75 of an acre. The dam is six feet high; the south abutment of the dam is formed into a receiving chamber and inlet of conduit line, and is provided with a movable inlet weir, which may be raised or lowered to allow any quantity of water up to the capacity of conduit to flow into the chamber and thence into the conduit; the saddle of the dam is two feet above the top of conduit. The water starts off from the receiving chamber in a 20 in. iron conduit pipe for fifty feet, to take the first shock off the water acquiring its velocity; it is thence continued with 20 in. vitrified salt-glazed stone ware pipe for 10,000 feet grade eight feet to the mile, the line following the contour of the ground required to give the necessary fill on top of pipe to protect the same, and to insure its lying in natural and not artificial ground. Here a heavy sand cut is encountered for about 1,000 feet. From this point, as a heavier grade can now be given, 18 in. vitrified pipe begins and continues 9,400 feet, grade 13 feet to the mile, to the edge of the basin of Gillett creek; from here the line is continued with an 18 in. cast iron pipe 6,200 feet long, which follows along surface or contour of the depression of

Gillett creek, rises up to the southerly side of said depression, and ends at a point at which the hydraulic grade line produced would give natural ground to start off with vitrified pipe again.

Vitrified pipe starts here, 18 in. diameter, and is carried along on the hydraulic line to the beginning of the depression of Cathaticane, or Crum creek, 9,100 feet. From this point 16 in. iron pipe 9,400 feet long, grade 32 feet to the mile, is used across the depression and up to the top of divide, the southern shed of which runs to the village of Little Falls. From this point 15 in vitrified pipe is again used for 900 feet, grade 79 feet to the mile; then 12 in. vitrified pipe is used for 1,000 feet, grade 105 feet to the mile; the conduit proper stops here, a total distance of 8 72-100 miles.

SPECIFICATIONS FOR PIPE.

The essential points in the specifications for the salt-glazed pipe which I adopted are as follows:

LITTLE FALLS WATER WORKS—SPECIFICATIONS FOR SALT-GLAZED VITRIFIED PIPE.

The pipe shall all be of the best quality of salt-glazed vitrified stone ware pipe. All shall be of the kind known as "hub and spigot."

The pipe shall have a thickness of one twelfth the diameter of the pipe. (This it will be observed, is heavier than the ordinary commercial pipe.)

The hubs or sockets shall be three inches deep to the main pipe. (At Amsterdam I used the ordinary depth of sockets, which is two and one quarter inches, but at Little Falls increased the depth to three inches, my experience convincing me that the increase would make easier and more satisfactory work.) All hubs or sockets must be of sufficient diameter to receive to their full depth the spigot end of the next following pipe, without any chipping of either pipe, and shall have a space or joint room of not less than three eighths of an inch in width all around for the cement mortar joint.

All pipes supplied shall be moulded under pressure, and the socket of every pipe shall be pressed on or formed with the body of the pipe, and care shall be taken that the sockets are truly concentric with the pipes. All pipes shall be cylindrical, and the spigot end of every pipe shall fit into the socket, leaving the thickness of joint not less than that specified. Five per cent will be the allowable inspection divergence of the greatest from the least internal diameter, in departing from a true cylindrical cross section.

The pipes shall be well glazed all over. All pipes not well or uniformly glazed will be rejected. All pipes not perfectly burned will be rejected. All pipes having any fire cracks which the engineer of said water works shall consider injurious, shall be condemned and their places supplied by other pipes.

All pipes having transportation cracks shall be peremptorily rejected.

All pipes having blisters which the engineer of said water works shall consider injurious, shall be condemned and their places supplied by other pipes.

All pipes having excresences or iron pimples in the interior

of the pipe, which in the opinion of the engineer aforesaid may impede the flow of water, shall be rejected and their places supplied by other pipe.

All pipe not thoroughly vitrified or fused, or which betrays the use of improper materials or methods in its manufacture, shall be rejected.

If a piece be broken out of the rim forming the hub or socket of a pipe, it shall be rejected, if the length of said broken piece is greater than one tenth of the diameter of the pipe, measured on the inside face of the hub or socket; provided, however, that the body of the pipe shall be perfect and without breaks or cracks.

If a piece be broken out of the socket end of a pipe which shall extend over one inch into body of pipe, to sound pipe, or shall be greater in length than one tenth of the diameter of the pipe, the pipe shall be rejected, and two or more such breaks, either of socket or spigot, shall condemn such pipe, even if both are under the area designated.

SPECIFICATIONS FOR PIPE LAYING.

The method of laying the pipe appears by the following specifications:

The excavations in conduit trench, both iron and vitrified pipe, shall be made to the lines and grades to be given by the engineer from time to time, and in such manner and to such widths as will give ample room for building the structures they are to contain.

The conduit will be laid to true grade from end to end of each section of vitrified pipe. The cast iron portion of conduit shall be laid to conform to the contour of the ground where laid, and trench shall be of such depth as to require a back fill of 3½ feet on top of pipe when laid.

The joints of the vitrified pipes shall be made of Portland cement mortar, in combination with gaskets of clean, sound hemp yarn or jute, braided or twisted, and tightly driven, as follows:

Each length or strand of the jute shall be of a diameter to loosely fill the width of joint, and shall be thoroughly soaked in a Portland cement mortar, made of a thick paste of clean cement and water, and shall be of a length to go once around the circumference of the pipe and lap over two to three inches. This shall be driven home with caulking tools, and shall be succeeded by a sufficient number of strands to fill the joint-room to within one half an inch of the outside of bell, breaking joints with the laps. All driven home and thoroughly jointed together. The joint shall then be finished by filling the remaining one half inch of joint-room with a clear Portland cement mortar, the joint-room when finished being completely filled all around the pipe to the outside lines of the bells.

The contractor will furnish the pipe layer with a bag, stuffed with shavings or hay, of a size sufficient to fit the pipe, rather tightly, with a rope about ten yards in length fastened at one end to the mouth of the bag.

The bag must be placed in the first pipe, the rope passing through each pipe as it is laid down. After the joints are made, the bag is then to be drawn forward at such times before the

cement has set as to smooth off and produce a true surface at each cement joint and a continuous thin coating of cement on the lower half of the pipe.

In refilling the trenches, the earth shall be carefully packed and rammed with proper tools for the purpose. Care shall be taken to give the pipe a proper bearing throughout the entire length. The earth filling above the pipe shall be sufficiently packed and rammed to prevent after settlement, and puddled to the satisfaction of the engineer when so directed.

In rock excavation, the material around the pipe and for 1½ feet above the same shall be earth, free from stone or rock fragments. The balance of the trench may be filled with such portion of the rock excavation as shall measure not more than one cubic foot, provided a sufficient amount of earth be mixed with the same to bond it together like a mortar, and if necessary suitable material satisfactory to the engineer shall be borrowed to make said filling.

For the first hundred feet from the receiving chamber the pipe shall be bedded in a wall of mortar extending all over the bottom of the trench and extending up to pass the center of the pipe, filling the trench completely up to this point. The object and intent of this being to prevent an under leakage at the beginning or receiving chamber end of the conduit.

In order to secure a natural bed for each pipe, the contractor will cause the trench to be excavated down to such depth as the engineer shall direct, by the regular trench gang, to be followed up by a trained gang to dig the additional depth, just to grade as fast as the pipe is laid.

Having now in detail described the method of laying out and constructing the vitrified pipe conduits, I submit the following remarks on the durability and cost as compared with a cast iron conduit of equal capacity, using the Little Falls conduit as the basis of comparison, that being the more elaborate and difficult construction, as also introducing the feature of substituting cast iron pipe in the intermediate sections where pressure in the pipe is encountered.

DURABILITY OF VITRIFIED PIPE.

That sound vitrified pipe is itself durable would seem hardly worth devoting much time to demonstrate. Sewers built of it have been unearthed in the excavation of Pompeii and Herculaneum, which cities were destroyed by an eruption of Vesuvius, A. D. 79.

REV. F. S. DE HASS, LATE U. S. CONSUL TO JERUSALEM, PALESTINE, WRITES:

"Vitrified Clay is among the most durable materials known. While the Marble palaces, temples and tombs of Rome and other ancient cities have crumbled to dust, those built of brick remain almost perfect. The use of Terra Cotta for images, ornaments, drain pipes, coffins and vessels of different kinds, dates back to the remote ages. Sewers, and tiling used in construction, have been found in Pompeii, Troy and Ninevah, also in Ur of the Chaldees, the home of Abraham, and the oldest cities in the

world. Here it was in general use, and the tombs are drained with clay pipes as sound as when laid in the ground 4,000 years ago.

"The coffins also are of the same material, and of different shapes, some like caskets with lids and others round like bottles, which were sealed up after the corpse was inserted; and there they are by thousands at the present time, sound as when they came from the potters' hands. Nothing is now known more lasting than Terra Cotta."

Whether the ancients used salt to glaze their pipes with does not appear, but that it adds to the durability of the pipe the following description of the process of glazing will make manifest:

Salt-glazed pipes are necessarily made from good clay, which will stand a great degree of heat. The pipes, after being made and dried, are placed in a close kiln and gradually subjected to an intense heat. When this heat is of sufficient intensity, coarse salt is thrown upon the fire in small quantities; a portion of the salt vaporizes; which vapor, combining with the silica of the clay, produces a soda-salt or glass, which is a glaze and is a part of the body of the pipe. It requires good clay to endure heat of sufficient intensity to vaporize the salt, and this heat is so great that the pipes are thoroughly vitrified and very hard, and glazed inside and out.

DURABILITY OF CONDUIT AS LAID.

As the Conduit as laid upon my plan, i. e., laying the pipe to the hydraulic grade line required to discharge the amount of water needed, will always be a line of no pressure, conditions precisely similar to the ordinary sewer as laid, there can be no tendency to rupture or break of any kind due to the water passing through the conduit, and the only danger to be apprehended is from an external pressure crushing the pipe, or to an unequal bearing or settlement of the conduit. The following tests show the strength of the pipes to resist external pressure:

Tests made by Mr. A. V. Abbot, Engineer, New York. A wooden box was made large enough to receive the pipe and allow from two to three inches of sand to be packed in at the sides, giving the pipe, as near as possible, the position it would occupy when laid in the earth. The pressure was then put on top of the pipe, with the following results—average of two pieces each size—each piece being twenty-four inches long:

DIAMETER.	THICKNESS.	CRUSHED AT
18 inches.	1½ inches.	14,233 lbs.
15 "	1¼ "	24,030 "
12 "	1 "	11,540 "
6 "	⅞ "	28,065 "

Again, the fact is that in deep cuts the filling over the pipe is partially supported by the sides of the cut, the angle of support or repose of the back filling being at an angle of 45° with a horizontal at the top level of the pipe, the earth or back filling forms an arch bridge from this point up, so that the only point to be carefully guarded, is to see that the back filling immediately surrounding the pipe is carefully put in, and that the pipe

is laid on the natural ground, so that there may be no undue, unequal settlement, and in places where the ground is soft and yielding, to build up with concrete.

RESULTS AT AMSTERDAM AND LITTLE FALLS.

That the results of construction bear me out in this, I have the proof in the actual working of both the Amsterdam and the Little Falls conduits. The Amsterdam conduit is laid generally in very heavy cuts, ranging from 12 to 22 feet. At Little Falls, one heavy cut for 1,000 feet is in the deepest point 32 feet; and yet, Mr. A. H. Delgraff, Superintendent at Amsterdam, writes in every report to date, that there has been no repairs on the conduit. His last, the sixth report on the works, 1887, says:

"CONDUIT LINES.—The conduit lines still continue to do the work assigned them in a satisfactory manner, and no moneys have been spent in repairs during the year."

At Little Falls the upper half of the conduit to Gillet Creek has been in use two years, and the whole since July last, and as yet there has not been one dollar's repairs, although on the iron portion we have had three breaks. If the proof of the pudding is chewing the string, I think these two conduits have demonstrated their durability. The same thing holds true of the Johnstown works.

The conduit at Johnstown is about 1 mile long, 15 inches in diameter and similar in construction to the Amsterdam conduit. It has now been in use four years without any repairs.

CONTINUITY OF SMOOTH PIPE.

I desire to call attention to the fact that the use of a bag drawn ahead continuously, after the pipe laying, has the effect of producing a continuous smooth pipe the entire length of the conduit, the small particles of cement mortar which are forced up into the chamber of the pipe in caulking being smoothed over in the line of the flow of the water and the joints entirely obliterated. Very careful measurements on a weir at the outlet of the Little Falls conduit showed, when conduit was running, full head, a daily flow of 4¼ million gallons, although the calculated capacity was 3 million gallons.

VALVES IN LINE.

To prevent a pressure ever being put on conduit, under no circumstances must any valve be placed in the line, but it must be an open conduit from end to end; the water must be regulated at the head, or by introduction of a branch pipe with valves on branch, which may then be located at any point at which it is desirable to draw the water off. On the Little Falls conduit I placed branches and blow-offs on each section of the iron pipe at their lowest points.

ECONOMIC FEATURES OF COST.

The most important item in the whole matter, however, is the relative cost as compared with cast iron pipe. The saving is well worth looking into wherever new works are being designed, or additional supplies added to existing systems, to see if it is applicable to the case in hand.

Taking the actual results of the cost of constructing the Little Falls conduit, the comparative statement, excluding the cost of dam, inlet chamber, etc., common to any plan, will be as follows:

Total cost of conduit, 8 72-100 miles long	$86,085 27
Vitrified Pipe portion, 5 63-100 miles long	45,544 43
Cast Iron portion, 3 09-100 miles long	40,540 80

If cast iron pipe had been used exclusively in place of vitrified pipe, the sizes, owing to the contour of the ground, would still have been the same as were used in the line as actually constructed; the total cost of conduit at contract prices would have been $147,409.29.

If it had been possible to follow on the hydraulic grade line the entire length of the conduit, using vitrified pipe exclusively, the total cost would have been $57,206.64.

The relative cost, Vitrified and Iron, may be generally summarized as follows: Taking the ordinary trench, say 4 ft. covering on top of pipe, 3 miles of vitrified may be laid for the cost of one of iron. The cost of laying vitrified, trench being all ready, taking 18-inch pipe as a basis, one expert pipe layer and four laborers will lay 200 to 300 lengths per day, using ½ bbl. cement and 50 lbs. jute. The collaring followed up the next day by one handy man and two laborers, using ¾ bbl. cement and ¾ bbl. sand.

From the actual workings of the conduits at Amsterdam, Johnstown and Little Falls, I am satisfied that, if properly laid, a salt-glazed pipe conduit is as durable as any that can be laid, as well as being economical, as the above results of actual work show There being no pressure, there can be no breaks to repair; maintenance is reduced to the minimum.

LIMITATION OF ITS USE.

Yet I think I must state that the application of vitrified in place of cast iron pipe must be limited to conduits of two feet to thirty inches in diameter, and to those localities where a line can be run to follow the hydraulic grade line, terminating at a distribution reservoir adjacent to town, which will give sufficient head for the distribution system, or ending at a pump well.

CONCLUSION.

I believe that the use of vitrified pipe conduits will enable many localities to avail themselves of the better and purer water supplies, that are, without its use, too far distant to be financially available. For example, the Little Falls water is brought at such a moderate cost as to enable them to sell their surplus water at a profit at five cents per 1,000 gallons. It would have been too heavy a burden with cast iron, or at least the tax-payers would have objected to the heavy expense. They probably would have resorted to pumping from the Mohawk river, which takes all the drainage of the cities above them. In the one case they have a pure mountain trout stream of three to four million gallons flow. In the other they would have had the sewage-contaminated Mohawk river, the constant daily expense of pumping, with no surplus of water to sell.

MR. WADSWORTH:—What are the lengths of the pipes?

MR. BABCOCK:—Two feet.

MR. WADSWORTH:—When these sections are laid is each one embedded in the earth before the joint is made and cemented?

MR. BABCOCK:—Should you fill and tamp you could not drive the joint. You are obliged to lay the pipe and drive the jute home then tamp the earth around the pipe.

MR. WADSWORTH:—Do you ever have any breaks in the cement?

MR. BABCOCK:—No, sir; the work has run six years and there never has been a spade put into the ground.

MR. WADSWORTH:—What do you mean by TRUE Hydraulic Grade Line?

MR. BABCOCK:—It is the grade at which the impetus given to flowing water by the incline, is just balanced by the retardation due to its friction. The line you follow—the contour of the ground—is not the true line. I have brought with me the maps of the construction. I shall exhibit them if anybody cares to see how far the contour line will depart from the true line.

MR. WADSWORTH:—In going through soil filed with quicksand or soft muck, do you have any trouble in keeping your conduit clear?

MR. BABCOCK:—At Johnstown they had originally iron pipe, and ran it very near an air line; it has constantly worked bad; and the Engineer called me in to help him. He was unfortunate in building a high dam on quicksand bottom; I abandoned that entirely and built a stone dam, packed and concreted it. We laid a twenty inch sewer from our reservoir over a very short distance, this was about two-thirds quicksand. I had to resort to an experiment; there was so much sand came through as to make a perfect stream below the conduit. I laid it with open ditches and put rye straw around the joints to catch the sand and retain it there. If I had a muck bottom I should concrete it, or lay timber and make a solid foundation.

MR. DUNHAM:—It is stated in the paper that the actual delivery through the conduit was four and a half

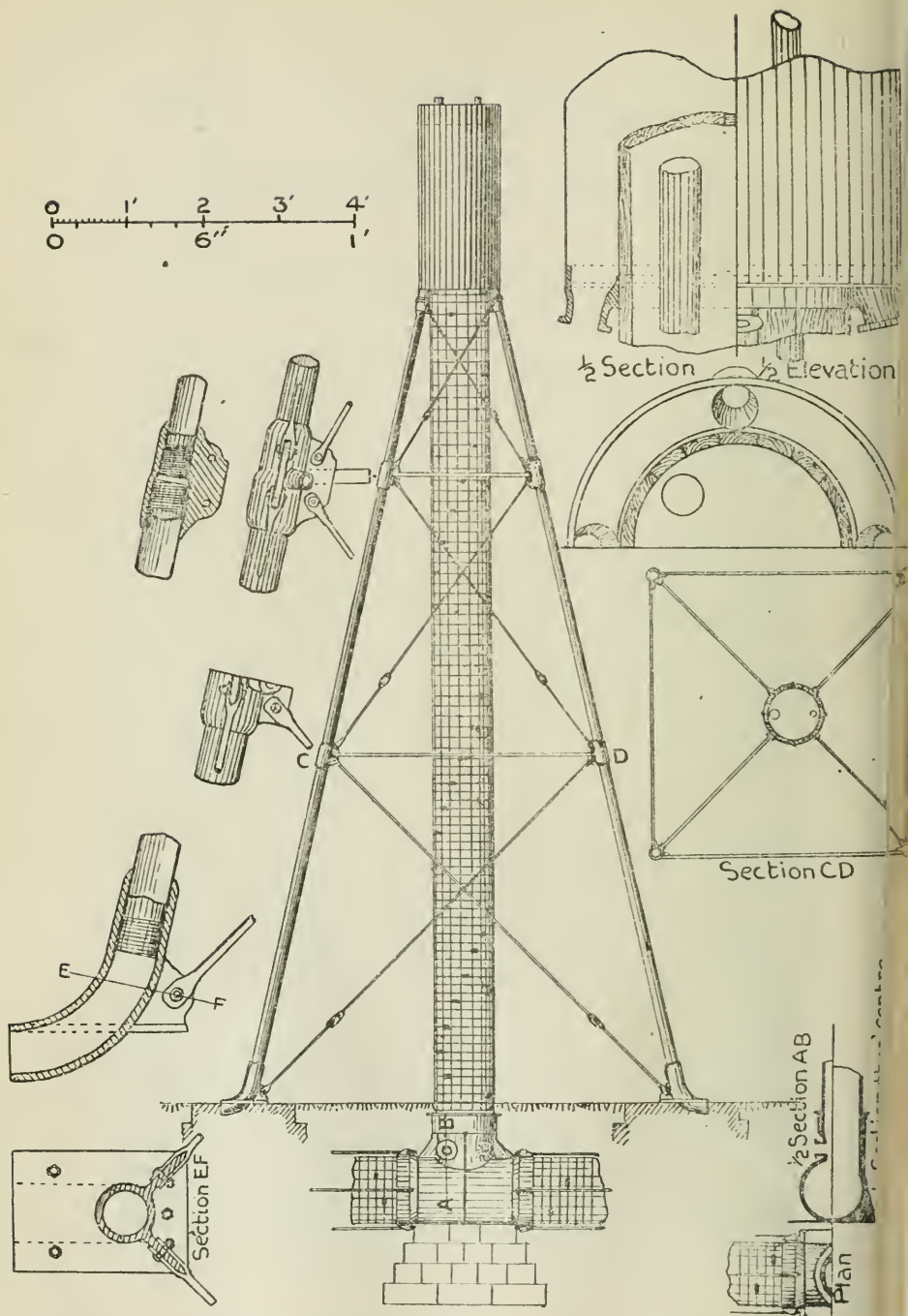
millions daily, while the computed capacity was three millions. I would like to inquire as to the formula used.

MR. BABCOCK:—I used Neville's Tables, but it has been found by actual measurement that the tables are about one-third short; I use them because they are commonly cited.

MR. DUNHAM:—It is also stated that the pipe for the purposes of a conduit of less than eighteen inches should not be used.

MR. BABCOCK:—No, sir; that is not so; not above twenty-four or thirty inch; simply because it is a difficult matter to manufacture; after you get above thirty inches the pipe in drying will get out of shape; and another thing, the pipe would be very hard to handle in a rough country.

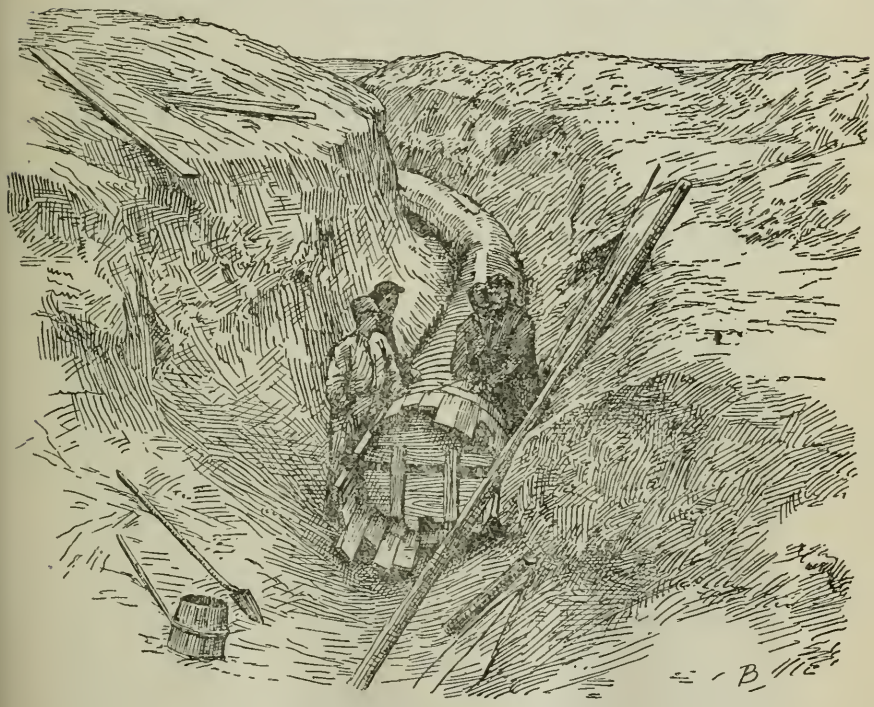
MR. HOLME, JR.—None of us of course will dispute the durability of salt-glazed vitrified pipe in the building of conduits, for we know it has durability and lasting qualities, but there are certain defects in it which I think have been overcome by the system of constructing a conduit recently used by us at Denver, which is now working very satisfactorily. We have had some of this work in use for six years, which was simply put in as an experiment; we have since built 7 or 8 miles of 20 in. to 36 in. conduit, which has cost us from $1.10 to $2.15 per ft. It will stand a pressure of from 10 to 60 lbs., and we have had it under the pressure of 40 lbs., with no ill results. We have 2½ ft. fall per mile in this conduit which I mention. It is constructed of California redwood, the durability of which I think is equal to that of solid or vitrified pipe. I was sent into California I think about 3 years ago to look into the durability of California redwood. I traveled up and down the State, visited the redwood forests, saw railroad ties that had been in use 40 years, saw piles that had been driven from 15 to 20 years, both in almost perfect condition, and saw a railroad manager's office that was finished off with railroad ties that had been in use 25 years—they having been sawed into proper form and sizes. We had this redwood sawed in the form of staves, a certain number of staves to the circle. We built our pipe by laying these staves one upon the other and then fastening them together with wrought-iron bands. Indeed, all the staves are bound in this way. The pipe is thus enabled to stand a very heavy pressure. They are placed 3 or 4 ft. apart on the pipe. Since we have had



DETAILS OF REDWOOD STAND PIPE. CHAS. A. ALLEN, DENVER, COL., ENGR.

this conduit in operation we have never had any leakages and have no trouble at all. The cost of this work is materially less than that of any other material now in use. The wood is made perfectly smooth before putting together, and the plan of construction is very simple and valves can be used on any part of the pipe. Our pipe, which is banded together with 5x8 in. wrought-iron bands and is under 60 lbs. pressure, has not a leak in it—I think we have something to be proud of. The diameter of the pipe I speak of is 24 in. We also have 30 in. under 40 lbs. pressure. Our reservoir is situated on the highest hill in the city. One advantage is that a valve can be placed at any point on the line, and the cost is so small comparatively that we could afford to build 5 or 6 of these conduits in the way described cheaper than we could put in one regular cast-iron line.

The drawings of this pipe are here on exhibition. This pipe is simple in construction and we find it a good conduit and quite satisfactory. We have, as I stated,



LAYING REDWOOD PIPE.

seven miles of this pipe 36, 30 and 24 inch diameter, made of California redwood, and of native pine about six miles; the native pine is forty-eight inch diameter.

MR. TUBBS:—Do you ever have a break in your pipe? Can you shut off the water to make repairs as readily as you could a cast iron main?

MR. HOLME:—Before the pipe had seasoned sufficiently we turned the water on, and the result was that very little water oozed from the pipe—not enough to spurt, but just a little ooze. As soon as the pipe had swollen, we had no further trouble with it. We can build under water or in water, can build in two or three feet of water, and we find no trouble in connecting this pipe with cast-iron pipe. We tested the pipe before we laid another; we tested it to 120 pounds pressure per square inch. The only question is one of durability. There is no question but that it will last 25 or 30 years—we could afford to build it half a dozen times (as I have said before) for what it would cost to put in one line of cast-iron pipe.

THE SECRETARY:—The City of Quincy, Ills., has lately put in a 30 inch conduit of similar construction to that of Denver. In this case they used Georgia Hard Pine, and laid it continuously, joints being broken as the staves were laid; the pipe was laid last winter, as the influent from mid-channel in the river to the pump well, and is from 1600 to 1700 feet in length, and is giving satisfaction.*

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*NOTE.—Since the meeting Col. E. Prince, C. E., has furnished the following, describing the Quincy conduit. SEC'Y: The pipe or conduit was built on ways—in 3 sections of 540 feet each—and rolled into the Bay, then put together with wrought iron ½ sleeves, towed into the river, ballasted with stone, sunk, entered into a short pipe running out from the well, the crib put on and then sunk together with the upper end of the conduit. There were a great many things to be thought of and provided for and against, both in construction and in getting in place. The construction of the pipe itself was exceedingly simple. Staves, 3 in. x 6 in. x 16 ft of best kiln dried yellow pine were used. After being brought here the whole was taken to planing mill and each stave dressed on inside and two edges. 19 staves went around the circle, the inside of which was say, 30 in. outside 36 in. I did not bevel anything; the end of each stave was sawed into to a depth of 2 in. to receive a wrought iron butt plate ⅛ inch thick; plate say 4½ in. wide x 4 in. deep. The object of this is to assist in making the butt joint tight A half inch groove in the edge of each stave is filled with a separate tongue piece say 7-16 in x ⅞ in. wide, put in as the pipe is being constructed, butts of tongue pieces never being allowed to coincide with stave butts. Over each joint on the outside of the pipe placed No. 8 wrought iron plate 6 in. square, nail hole punched in each corner, through which hole nail was driven and clinched on inside of pipe. What bothered me most, and was the simplest thing about it, was the hooping. Of course, the pipe being perfectly straight, there was no chance to drive, and bolts were on many accounts objectionable The plan I last thought about, and adopted worked like a charm, and was thus: At distances of 4 ft. i. e., covering all the butt joints and plates, passes a half inch c. h. iron hoop held in place by a half clamp, secured by a draw bolt. This clamp is tightened outside of the hoop until a link can be slipped over the bent ends of the hoop, when the ends are turned back over the

MR. HOOPER:—It has been done abroad in the French country fifty years under an eighty pound pressure. I saw in the Sonora Valley two years ago, a similar conduit in which water was brought down from a very high mountain and which had been in use eighteen years.

MR. DUNHAM:—If there is any question as to durability of wood pipe, I think our President can tell us as much about it as anyone.

PRESIDENT FANNING:—In constructing a system of water-works, in an Eastern city, I had to deliver water from the storage lake to the pumping station and to the turbines driving the pumps which were placed at a level 40 ft. lower than the lake, and distant more than a quarter of a mile from the lake. The water was conveyed from the dam at the outlet of the lake about 1,000 ft. in a canal to the brow of the slope at the foot of which stood the pump house. The water was to be taken down the slope to the pumps and to drive the turbines which actuated the pumping machinery. After consideration of several methods of construction of penstock for this purpose, a wood conduit was deemed advisable. The canal on the upper level was 10 ft. deep and the bottom of the conduit at the end of the canal was placed at the same level as the bottom of the canal, and the conduit then extended 700 ft. in length down the slope and connected with the turbines under a head of 40 ft. This conduit is 72 ins. clear diameter. It is constructed of southern pine staves. These staves are machine dressed on their edges to true radial lines, and in setting the machine cutters I tested by setting short pieces of staves on end on a floor, and adjusted the cutters until the staves placed in contact one after another would complete a true circle of 72 ins. diameter.

The trench to receive the conduit averaged about 10 ft. deep. The staves in the conduit were laid so as to break joints as a long mill floor is laid. Forms, on which to lay the lower semi-circumference of the conduit were placed in the trench. Then starting at the lower end the staves were placed in position, the lowest staves being stretched up the slope farther than higher staves and

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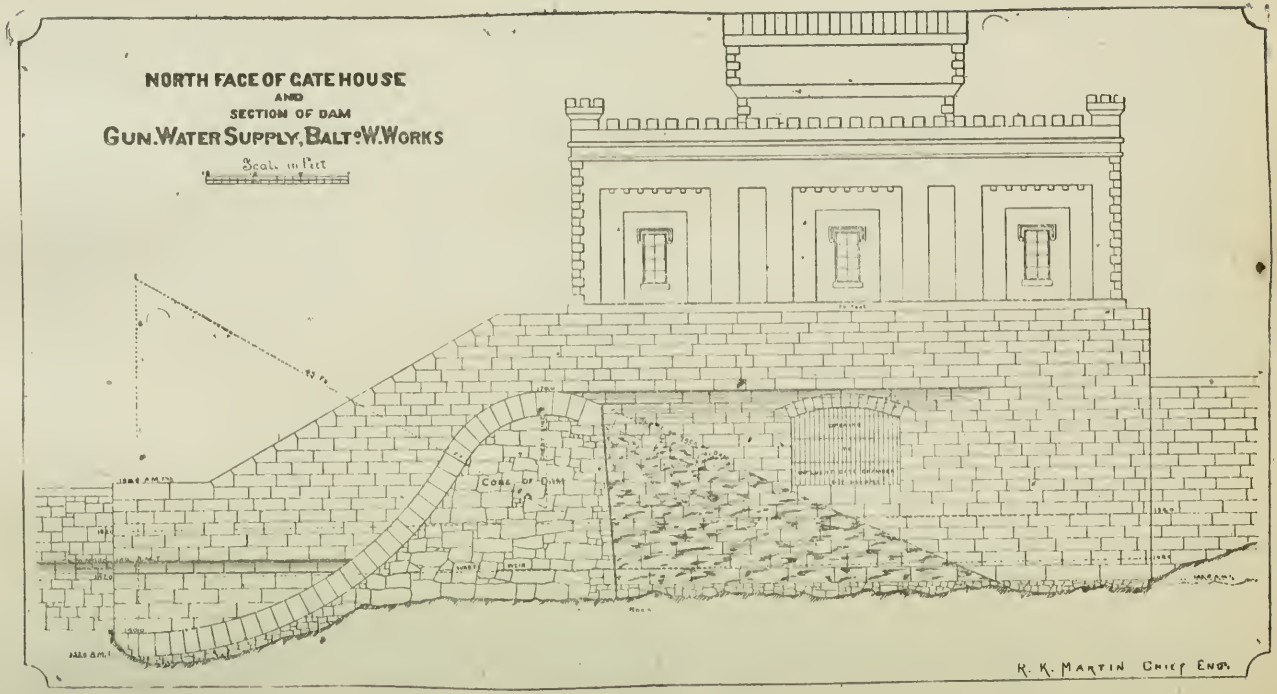
link, in so doing tightening the round hoop still more. After the bent ends were secured with the link and slightly bent back, the clamp was removed and the hoop rounded at all the seams so as to get a snug fit before the final driving back of the hoop ends. The sections of the pipe were secured by a half sleeve of boiler plate six feet long, in all cases a thimble of ⅛ inch iron entering and connecting each section. I used ⅝ in. round iron side rods running the whole length of the pipe from the crib to well anchorage. But the pipe was so stiff and strong that I doubt if they did any good.


NORTH FACE OF GATE HOUSE
AND
SECTION OF DAM
GUN. WATER SUPPLY, BALT^E W. WORKS
Scale in Feet
CORE OF DAM
R. K. MARTIN Chief Engr.

when the semi-circumference at the lower end was complete its iron hoops were placed in position and the full circle of the conduit completed. Thus the laying progressed up the hill, the lowest staves being kept in advance, and the iron hoops being placed and tightened as the full circle advanced. This work was performed by laborers under supervision of a competent foreman.

The hoops were made of iron 2½ ins. wide varying from ½ in. to ¼ in. in thickness, and each hoop had two tightening bolts at points opposite each other. The butting joints of the staves were made tight by introducing a thin plate of iron in each. Saw kerfs were cut tangentially, ⅜ in. deep across each end of each stave, and pieces of hoop iron ¾ in. wide and ⅛ in. longer than the width of the stave filled the kerf. The ends of the iron plates were sharpened so as to indent into the sides of each adjoining stave.

This six foot wood conduit, under 40 feet head pressure at its lower end has been in satisfactory use sixteen years, conveying water to the turbines and pumps and now gives promise of great durability.

One other instance I will mention, more intimately related to the subject of Mr. BABCOCK'S paper. This is a vitrified pipe conduct under pressure. We built an impounding resevoir by raising a natural lake 14 ft., thus securing a reservoir of 180 acres area. The dam was 14 feet high and the conduit leading water to the city was, in the gate chamber, placed at the level of the bottom of the dam. From thence it had a fall of 12 ins. per mile and extended 7,000 ft. toward the city, the remaining portion of the supply main being of iron.

At the lower end of the vitrified pipe was placed an open topped stand pipe rising to 3 ft. higher than the water in the lake reservoir. The use of the stand pipe was to lessen any shock of water ram that might possibly be reacted from the iron pipe back toward the reservoir.

This conduit is a Scotch clay vitrified pipe of 24 ins. diameter. Its joints are covered with wrought-iron sleeves packed with Portland cement. This conduit has been in use about twenty years under an average of reservoir pressure of 15 ft. head with satisfactory results.

MR. WADSWORTH:—In improving the water supply of a town in 1871, I ran across two wood mains of common size 6 ins. in diameter. These pipes were perfectly sound, except about 1 in. on the outside. I was told by some of the oldest inhabitants that they were laid 80 or 90 years ago and had been in use up to 20 years ago. They ran

1,000 ft. toward the mountain. These pipes, as far as I could see, were as ready to bring water as they ever were. Joints were butt or socket style.

MR. DIVEN:—We have wood pipe put in in 1860, under a pressure of 60 lbs., which is giving entire satisfaction.

PRESIDENT FANNING:—One of the conditions of the successful use of wooden pipes underground seems to be that the soil shall be constantly moist and one which is perfectly free from the circulation of air. In removing an old bridge from one of the New England streams we found that the sills on which the old pier or abutment originally rested, had evidently been laid in the ground at a low stage of the water. They were just on the water surface when we took them out. When they had been removed I took a chip from one of them which showed the wood to be in an almost perfect state of preservation, and I now have it as a curiosity. Upon investigation I found that the sills were put in about 100 years previous. The fibre was but slightly soiled, and was nearly as tough as that in new wood.

MR. DARLING:—I would say, that circumstances may allow putting in wooden pipe, or one of the various other kinds of pipe which have been brought forward; but, I believe, that if you live anywhere near a foundry where they make pipe at a reasonable price, and of good quality, the most practical pipe that you can put into the ground is cast-iron pipe.

THE PRESIDENT:—The next in order is a paper by Mr. H. W. Ayres, of Hartford, Conn.

Mr. Ayres then read:

THE CONSUMPTION OF WATER BY CITIES AND TOWNS.

The actual average daily amounts of water used and wasted, by American cities and towns, at the present time, especially as reduced to a per capita basis, is a difficult matter to determine. As might be expected, returns from the smaller cities and towns are usually less reliable, and show wider differences than those of larger, more wealthy and consequently usually better equipped and managed corporations. Moreover, local causes produce more conspicuous results where the plant is small and the area of distribution limited From a careful examination of reports and other authentic sources, I find that many towns, with a population of about 5,000, supply from 20 to 100 or more gallons per day to each inhabitant, fairly representa-

tive towns of this class furnishing usually from 35 to 40 gallons per capita. Towns with a population of about 10,000, though with wider extremes of supply, seem to furnish from 45 to 50 gallons daily to inhabitants. Of cities, with populations of from 25,000 to 50,000, very few use and waste less than 50 gallons daily to each inhabitant, by far the greater number supplying 100 or more gallons, and many wasting water in a way that could not be tolerated in a large city.

In order to illustrate the subject, I have prepared the accompanying table, made up entirely from the reports of the cities named. This table contains the names of about thirty American cities, and gives the per capita consumption of each, extending in some cases over a period of fifteen years, also the population, number of meters and number of service pipes in use at the same time of the last report. And while there are many breaks which I have been unable to fill, only three cities having answered inquiries, also parts in which returns are based on the company's estimate of population, yet it will, I think, be found sufficiently accurate as an exhibit of the present situation.

We must remember, however, that municipal and private corporations, which know and report their consumption, usually take pride in keeping it as low as possible; whereas those who, through lack of information, make no such report, especially cities using a gravity supply with ample storage, probably consume water in greater quantities. Any amount of waste, therefore, shown by amounts reported, is probably less than the actual average waste.

An inspection of this table shows that in most cases the use of water increases not only with the growth of the city, but with the lapse of time since the introduction of the works. It will also usually be found to increase with the extent of area piped. Referring to the table again, we find that where by an effort in almost any of these cities the consumption has been greatly reduced in one year, this effort has not resulted in further reductions in succeeding years, but forms only the initial point of a second constantly increasing scale. Neither is it true, as we might have expected, that a comparatively moderate use of water by cities where the source and facilities of supply are ample is attained in all cases by the measurement of water furnished.

In regard to these differences as shown, part are undoubtedly to be accounted for by the size of the city, its climatic location, manufacturing or commercial interests, topography, amount of pressure required in pipes and other local causes; but when we have made all allowance for such causes, the variations are yet far too great. Where we might expect comparative uniformity in supply, and wide differences only in the cost of the plant and operating expenses, we find cities in nearly similar situations as to population, etc., vary in this respect to wide limits. Yet the city, apparently so careful by comparison, is probably wasting from one-third to one-half of all the water furnished; and so long as one city can point to much greater waste by others, the tendency is to increase its own, the difficulties of a determined effort at reduction are increased, and a higher per capita basis is encouraged.

This encouraged waste of water has brought a number of our cities to a point where their works are adequate neither for

fire protection, nor domestic purposes. As, for instance, the city of New York, where the waste in some sections is so great that the usefulness of the plant is totally destroyed in other sections, notwithstanding the per capita consumption averaged for all is about ninety gallons, or more than two and one-quarter times as great as that of London, England.

In regard to what should constitute a proper supply, Colonel Wm. Ludlow, who has made a thorough and comprehensive study of this subject, says: "The domestic and public use of water cannot be made to account for more than forty gallons per capita." This for the city of Philadelphia.

His estimate is:

For domestic use	15 gallons.
For manufacturing purposes	20 "
For sprinkling streets	2 "
For fountains	2 "
For fire purposes	1
Total	40 gallons.

If Colonel Ludlow is correct, and I do not think anyone familiar with the subject will dispute his estimate, all in excess of an average daily supply of 40 gallons to consumers is waste, and any money expended in furnishing a greater amount is a loss, except such as has reference to an increased population or unexpected contingency.

The more important elements composing this excessive use of water by American cities, and the reduction of waste, are subjects which have been ably treated by members of this Association, in papers presented at former meetings. The more prolific sources of waste are:

1st. Improper plumbing and house fixtures.

2nd. The running off of water during cold weather to prevent freezing.

3rd. Street sprinkling as practiced.

To correct excess in these directions, we have but two remedies:

1st. Introduction of water meters.

2nd. A house to house inspection, aided by mechanical devices now at our command, and backed by strict rules rigidly enforced, yet in such a manner that the consumer shall not be made to suffer too great hardship, either in the matter of expense or convenience. There are cities where, by a judicious blending of these two remedies, the waste has been reduced to a minimum, yet without inconvenience to the consumer. However, they are very few, probably not more than 1-7 of 1 per cent. of all now in use.

The table on which this paper is founded furnishes the basis for longer and more varied comment than it is possible to make now. No fact shown is, however, of greater practical importance than the enormous useless expense inflicted on every community where reckless waste is the rule, and consumers are left practically at liberty to waste from two to eight times as much water as they can possibly use.

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GALLONS PER DAY PER CAPITA.

CITIES.	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887		Number of Meters	Number of Service Pipe.	Population at Time of Last Report.
Philadelphia	.....	58	.....	.....	61	64	65	68	71	76	76	74	72	80	.....	To Inhabitant.	284	.....	975000
Chicago	.....	96	....	103	.....	123	.....	112	....	110	....	113	129	.....	.....	"	2897	9866	.....
Wilmington, Del.	.....	.....	.....	.....	.....	59	69	80	94	94	103	96	89	92	94	"	.....	.....	50000
Detroit	90	....	....	102	105	.....	.....	125	.....	.....	..	144	170	....	180	"	44	28428	.....
Buffalo	.....	...	.	.....	....	.....	....	105	107	111	130	130	127	132	.....	"	126	26438	250000
Cincinnati	50	55	60	68	64	66	68	75	87	60	.....	.....	.....	...		"	.....	.....	...
Toronto, Ont	.....	.....	50	62	41	54	59	65	68	71	83	94	86	95	.....	"	256	23643	118400
Lynn, Mass	.....	74	75	60	56	55	56	49	48	.....	42	45	45	49	47	To Consumer	.....	.....	.....
	.....	35	.....	....	32	35	35	29	32	....	34	37	39	46	45	To Inhabitant	236	7800	52000
Louisville, Ky	65	64	58	64	65	65	71	88	109	90	95	89	105	104	....	To Consumer	....	.....	.....
	22	24	24	27	29	30	33	42	55	47	52	56	62	65	.....	To Inhabitant	471	10100	160000
Fall River, Mass	.....	84	70	48	41	36	35	37	39	45	38	32	30	31	27	To Consumer	.....	.....	50000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25	To Inhabitant	2725	3986	50000
Cleveland, Ohio	138	141	136	131	142	135	146	145	162	136	137	138	139	.....		To Consumer	.....	.....	.....
	43	45	44	49	56	51	62	65	76	68	75	82	93	.....	.....	To Inhabitant	.....	.....	
New Bedford, Mass	.....	.....	.....	.....	.....	.....	...	.....	122	114	105	100	113	104	.....	To Consumer	....	.....	.....
	.....	.....	.....		.....	.....	.....	.....	86	82	78	72	86	86	.....	To Inhabitant	82	5225	34500
Brooklyn, N. Y.	.....	..	.....	.....	.....	.....	...	55	58	59	61	.....	.....	...	66	"	2035	79073	700000
Milwaukee	...	.....	.....	...	....	.....	.....	106	.....	.....	.....	106	.....	113	.....	"	741	13243	158365
Troy, N. Y.	.....	.....	.....	.....	.....	.....	.....	58	.....	.....	.....	134	140	133	.....	"	45	5112	60000
Boston, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	90	73	71	74	80	"	8564	72039	475000
Taunton, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	42	43	38	To Consumer	.....	.....	19000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	29	28	32	31	To Inhabitant	776	2875	21000
Burlington, Vt	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45	48	.....	To Consumer	.....	.....	.....
	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48	44	43	47	..	To Inhabitant	.....	.....	13500
Rochester, N. Y.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79	To Consumer	.....	.....	90000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	57	68	62	To Inhabitant	1009	17454	115000
Springfield, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	104	129	134	To Consumer	.....	.....	.....
	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..	.....	77	96	100	To Inhabitant	472	4819	40000
Richmond, Va	.....	..	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	308	.....	To Consumer	.....	.....	.....
	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	141	154	.....	To Inhabitant	38	.....	70000
Waltham, Mass	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	.....	47	.....	To Consumer	.....	.....	14000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35	39	.....	To Inhabitant	20	1884	15500
Plymouth, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	97	.....	To Consumer	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80	.....	To Inhabitant	2	1284	7400
Newton, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	38	36	.....	To Consumer	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	32	.....	To Inhabitant	1592	3432	21000
Fitchburg, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84	84	84	To Consumer	.....	.....	14000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	65	63	59	To Inhabitant	545	2203	20000
Lowell, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60	60	60	To Consumer	.....	.....	65000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55	56	To Inhabitant	1461	7127	67000
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	54	.....	"	.....	4900	12063
Madison, Wis	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	"	40	.....	20000
Scheuectady, N. Y.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77	74				
Holyoke, Mass	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	73	73	To Consumer	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	71	71	To Inhabitant	149	2173	31348
Providence, R. I	.....	.....	.....	.....	25	27	30	34	34	32	.....	.....	39	40	41	"	7632	13361	120000

The next paper on the programme, "The Water Supply of Tokyo, Japan," by Y. Nakajima, C. E., of the Imperial University, was on motion read by title and ordered printed.

*THE WATER SUPPLY OF TOKYO, JAPAN.**

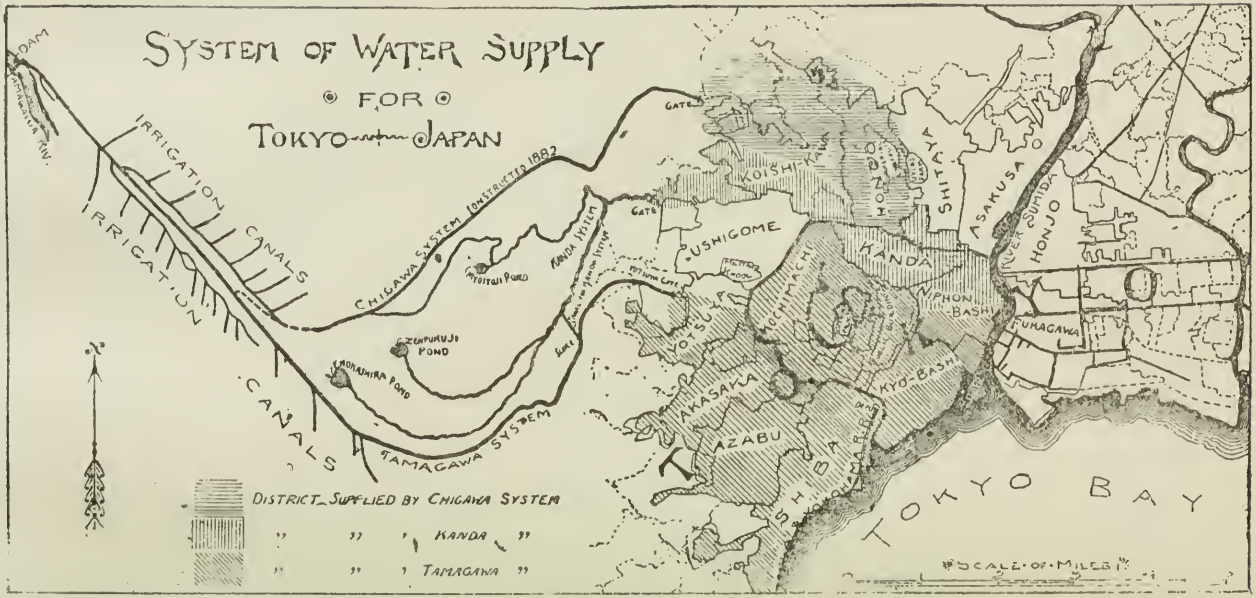
Tokyo, or formerly called Yedo, is the present capital of Japan and is the largest city in the Empire. On the south it is bounded by the sea, and on the north and west there are many hill ranges. The heart of the city is traversed by many transportation canals. Its total area is 15,279 acres or 23.87 square miles. The total length of the streets is about 477 miles and they are in general very narrow. Most buildings in the business part are two stories high. The population of the city proper is 1,210,000 or 72.7 persons per acre.

"When General Iyeyas decided to make Tokyo his headquarters, it was but a small town. But his policy was to have all the nobility under his eye, so he ordered them all to reside in Tokyo; and this caused a rapid increase in the population, as may be understood when it is remembered that some had armed followers to the number of one thousand, and each follower had his family." The water obtained was, in general, very bad and in many places it contained salts and was not fitted for drinking purposes at all. Also in some parts the supply occasionally failed. Consequently as the population increased, the necessity for water supply was greatly felt and the following works were carried out which, without material change, have supplied Tokyo until to-day.

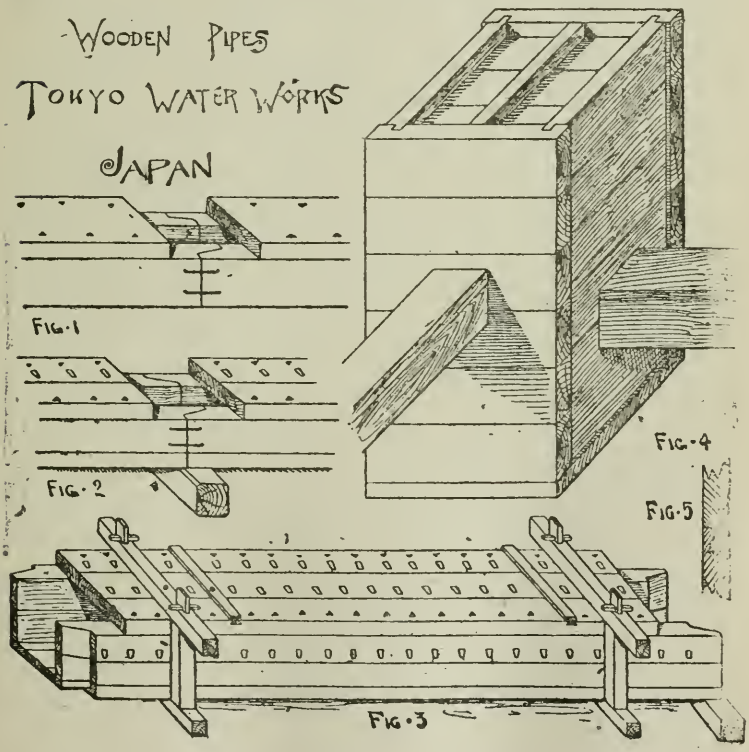
In 1620 (though some say a little later), one of the Shogun (General) ordered a man who had lived a long while in the neighborhood of Tokyo to consider the question of water supply for the city. He proposed and constructed what is now commonly called the Kanda system. The three ponds, namely that of Enokashira. Zenpukuji and Myo-syoji, are the principal sources of this system, and a part of the water of the Tamagawa canal helps them at present. The respective heights of these ponds are 147.5, 150.5, and 137.5 feet above the sea. The waters from these sources are combined in one canal and are distributed through a part of the city by various wooden pipes, as shown in the map. This system supplies the wards of Koishi-Kawa, Kanda, and part of Niphon-bashi. Its daily supply is about 17,000,000 U S. gallons.

The other is called the Tamagawa system, and is more important than the one already described. The Shogun noticed the insufficiency of the existing system, and in 1651 he ordered a nobleman to consider its extension, or more properly, the introduction of a new supply. It is said that accordingly two farmers who were well acquainted with the surrounding country, were appointed to make surveys and report. It is also said that

*The materials for this description were furnished to the author mostly by Mr. R. Hara, C. B of Tokyo-Fu, and a great deal is quoted by permission from Prof. W. S. Chaplin's paper, read before New England Water Works Association.


SYSTEM OF WATER SUPPLY
FOR
TOKYO JAPAN
DAM
IRRIGATION CANALS
IRRIGATION CANALS
CHIGAWA SYSTEM CONSTRUCTED 1882
GATE
GATE
KOISHI
ONI
SHIYA
ASAKUSA
HONJO
RIVER SUMIDA
KANDA HEIGHTS
KANDA
USHIGOME
NIHON BASHI
FUKAGAWA
MICHITACHI
AKASAKA
AZABU
KYO-BASHI
SHIBA
TOKYO BAY
SCALE OF MILES
DISTRICT SUPPLIED BY CHIGAWA SYSTEM
" " " KANDA "
" " " TAMAGAWA "

at that time there were no levels and almost no surveying instruments of any description at all. However, somehow or other, they made the survey and recommended drawing the water from the Tamagawa river. The plan was adopted and the work was begun in April, 1652, and completed in November, of the same year. They built a dam across the river so as to turn the water into the canal. The height of the water surface of the canal near the dam is 404 feet above the sea. The total length of the open canal from the dam to the Yotsuya gate is 26.6 miles. From the dam for about 0.7 of a mile, the width of the canal is about 30 feet and the width of the remaining portion decreases from 24 to 18 feet. "The canal was skillfully placed along the plain which extends from the dam to Tokyo, so that no high embankments or deep excavations were needed. The velocity of the water is rather great, but it is quite uniform from one end of the canal to the other. The high velocity is beneficial, because it prevents the growth of, and obstruction from aquatic plants, and the injury to the banks is less than would be expected, as the earth here hardens under the action of water." This canal serves also for irrigating the lands along the line. There are also several mills. The gate at Yotsuya regulates the water flow to



Tokyo and the extra water is drawn off by a waste pipe. The daily supply by this system is about 24,000,000 gallons. This supplies the following wards, namely: Akasaka, part of Yotsuya, Azabu, Kochi-Machi, Shiba, Kyo-bashi and part of Niphon-bashi, as shown in the map. The total number of the people depending upon these two systems is about 400,000.

There is another, called the Chigawa system, which supplies a part of the wards of Koishi-Kawa and Hongo, as shown in the map. The daily supply is 1,400,000 gallons.

Besides the above three systems, there had been introduced three or four other systems at various times, but none of them were successful on account of excessive cost of maintenance, and all had been abandoned.

The distribution pipes are generally of wood; in dry places retinispora obtusa is used, and in wet grounds pine is used for pipes. There are many forms of wooden pipes in use. When the internal diameter is much less than 6 ins. a round timber with a circular hole through is used. When the pipes are a little larger, then a square timber is hollowed out so that its section looks like a U and the top is covered with a plank which is spiked on (Fig. 1). The joints are well calked with a fibrous bark so as to prevent leakage. The connections between the ends of adjoining pipes are formed by champhering the end of one pipe and enlarging the interior of the end of the next and driving the first into the second (Fig. 1). The pipe of this form is used when the side of the interior hole is less than 6 ins. In larger pipes the section is either square or rectangular with the broad side laid (Fig. 2). The thickness of the planks forming the sides is from $2\frac{1}{2}$ to 6 ins. When these pipes are subjected to a considerable pressure they are braced by frames of square timbers, as shown in Fig. 3. The largest wooden pipe in use is 3 ft. in height by $4\frac{1}{2}$ ft. in width, and the smallest one is $3\frac{1}{4}$ by $3\frac{1}{4}$ ins. The largest stone conduit is 5 ft. in height by 6 ft. in width, and the smallest one is 1 ft. 6 ins. by 1 ft. 6 ins. The total length of the wooden pipes now in use is 533,790 ft. or 101.1 miles, of which 290,470 ft. belongs to the Tamagawa system, 221,210 ft. to that of Kanda, and the balance to the Chigawa system. The total length of the stone conduit is 24,625 ft. of which 12,070 ft. belongs to the Tamagawa system and the balance to that of the Kanda. The depth of the distribution pipes is from 4 to 18 ft. below the surface of the ground. The wooden pipes last from 10 to 20 years, according to the nature of the ground. The distribution pipes of the three systems are not connected at all, though in some parts they come close together. Whenever there is an abrupt change in level, or there is a branch pipe, a square box is used, as shown in Fig. 4, whose sides vary from $2\frac{1}{2}$ ft. to 6 ft, according to the sizes of the pipes. There are a great variety of the forms of the boxes according to the locality, the pressure, head, etc. In some parts, boxes are put simply for inspecting the flow and the quality of water. They may, to some degree, serve to make the flow in the pipes uniform. "The water is not carried from the mains into the houses, but is delivered into wells, which are usually on one side of the streets." Commonly the connection of the well to the distribution pipe is made by inserting one end of a 2-in. iron pipe about 3 ft. long to the side of the distribution pipe and the other end to a square wooden box 1 ft. $2\frac{1}{4}$ ins. wide and 1 ft. high, the thickness of which is

about 2½ ins. The connection of this box to the well is made commonly by a wooden pipe, the diameter of which is 2½ ins. The wells are generally lined with wooden planks 5 or 6 ins. wide and 2 ins. thick, fastened together by several bamboo bands in a cylindrical form. The height of each of these wooden cylinders is about 6 or 8 ft., and their diameter varies from 3 to 4 ft. The depth of the wells depends upon that of the distribution pipes near by. The top of the cylinder projects about 3 ft. above the ground surface so as to prevent the danger of falling in. The total number of these wells now in use is 7,765, of which 2,935 belong to the Tamagawa system, 3,704 to that of Kanda, and the balance to the Chigawa system. "The ends of the mains are carried down to the banks of the canals, rivers and the shore of the bay, and the water is allowed to escape freely, thus reducing the great pressure in the pipes and preventing injury to them." In this way a great deal of water is wasted, though the exact amount is not known.

Chemical examinations have shown that the water is contaminated in the distribution, for samples taken from the conduits showed no pollution, while those taken from the wells in the lower part of the city were decidedly bad. The analysis also shows that the water of the Tamagawa is much superior to that of Kanda. "Several theories have been advanced to account for its contamination. One is, that as the pipes are usually below the level of the ground water, though the head is greater inside the pipes, there is a continual diffusion of the impurities in the ground water through the wood into the pipes. Another and more probable hypothesis is, that owing to the constantly changing level of the water in the wells, which arises mostly from the small size of the pipes which connect the mains with the wells, the impure water from the ground makes its way through the leaky linings into the wells and that the water thus polluted is carried at times back into the mains." In another experiment water was taken from the different parts of the systems on the same day, and the analysis of these different waters showed that the further the water flows through the distribution pipes, the greater is the contamination, and in the thickly settled places the impurities are found to be more than in the thinly inhabited portions.

The water rate for one well is $4.50 per annum. A fountain rate is double, and a waterfall rate is ten times that amount. The average annual cost of maintenance for the three years (1883, 1884, 1885,) is $27,800.

Nearly all the people of the Fukagawa ward, and about one-fifth of those of the Honjo, altogether 89,450 in number, use water brought daily by boats from some distant rivers or from the outlets of the already mentioned systems. The quantity conveyed daily by these boats is 77,200 gallons. The daily cost of transportation is about $45.00, or $16,425 per annum.

In the places where the above systems do not extend, the people use the water of the common wells and of artesian wells. The total number now in use in the capital is 33,952. In general the water from the common wells is much inferior to that of the already mentioned systems.

As the water of these systems has no head and as in many places it can hardly be obtained with convenience, the losses due to fire are quite great. The area covered by the buildings

burnt in 1883 is thirty-seven acres; in '84, twenty-six acres, and in '85, thirty-two acres. Nearly all the buildings are only one or two stories high, so that the losses due to these fires are not so great as might be supposed. It may be fairly estimated that the losses from buildings burnt in these years are $669,000, $473,000 and $585,000 respectively.

About two hundred and fifty years ago, very little was done toward systematic water supply even in London; and the water works of Tokyo were quite large for that period. In fact, up to that time, there had been no such extensive water works constructed in the world except at Rome. However gigantic, as it may have appeared at the time of its construction, it cannot be comparable, in many respects, with the present systems in America and Europe, and therefore it will no doubt, be replaced by some bettor system in a few years.

MR. DARLING:—What is the programme for this evening; are we to have a session?

CHAIR:—No, sir.

MR. DARLING:—Then I rise to a question of privilege. I am situated at the present time so that I know not whether I will be with you after this session or not. I have a communication from my chief assistant who lies dangerously sick at home; I expect a telegram which may call me home to-night. Now I desire to have a word to say in case I do go.

Last year I sent you a package of blue prints, with the request that the same be distributed among the members with a view of trying to encourage the system of each member bringing blue prints of his work. I think these things will be somewhat practical and very useful to all. This year I brought down another package for distribution; the President has contributed from his stock largely; this I desire to see done by all members. A great many say "I cannot do that; I cannot do that." It is just as easy as to sit down and write a letter, if you go to work at it. If you are not a Civil Engineer just draw out your ideas and then submit it to a Civil Engineer, or a draughtsman, and he will have them printed for about two or two and a half cents apiece.

Now, what I desire is, that this Association will resolve that each member will bring some blue prints of some part of their work, either their system generally, the manner in which they take their water, some river crossing, which would be interesting to us, where you have gone either over or under the river; something that will give us an idea of what somebody else has done. I feel so much interested in this matter that I want to put the question to the meeting before I leave, because I believe this Asso-

ciation is large enough and that we have members able to do it. Some men say they cannot talk; you must not ask them to say anything. I have seen these gentlemen by just asking, "How do you do this thing?" get up and make a good speech. I would like to have the expression of the members of this Association whether they agree with me in this idea or not.

Now I would like these gentlemen who will help in this matter to stand up and be counted, (members rising.) That is good business. This does not prevent anybody that does not rise to present some. Well, we have fifteen or sixteen rising. There is another thing; they should be of a uniform size so as to be bound. [A voice: What size?] The size I shall present you, and the size you received from me last year is our uniform size. Of course if it is more convenient you can make it larger. You have many larger works than we have in the East. Now I desire to say the New England branch is an offspring from this Association; I was one of the instigators of that association. This organization was started at St. Louis by Mr. W. C. Stripe, (who is now dead), a man of good ideas, and a hard worker, Mr. Decker, and others I cannot now name. Beginning with a few Superintendents of Water Works it has grown to large proportions. I met with you at Columbus the second annual meeting; I said then I thought perhaps it would be well to start a similar society in New England. I had hoped that New York, and that the Southern States would start similar ones, whereby this Association might be a grand head, or Grand Encampment, or Grand Lodge to the rest of them. I thonght this would be the foundation only. Now I want to say that the New England Society looks to this Association, at least I do, recognizing it as the parent; she is the child of this Association; she needs you, and believes in you without a question, and is willing to submit to the parent. I want to continue this sociability between us. We hold a meeting in June at Providence, R. I. I would be glad to see you all there and tender you all a cordial invitation to come. I hope these meetings will be continued and grow; I am pleased to see the growth of this Association, and I hope we shall continue to be a grand center of some other societies that will co-operate with us in these deliberations. [Cheers.]

Adjourned.

MORNING SESSION, WEDNESDAY, APRIL 18TH, 1888.

Meeting called to order at 10 o'clock by President Fanning.

Mr. Dunham, on behalf of the Civil Engineers' Club of Cleveland, extended to the Association greetings, and an invitation to attend a meeting of the Club in the evening to listen to an address by its President, Mr. John Whitelaw, on the construction and history of the Cleveland Water Works, and stated that the City Council had kindly tendered the use of its chamber for the evening. It was moved and seconded that the courtesy of the Civil Engineers' Club be accepted. Carried.

Mr. Dunham stated that he had received a letter from Messrs. Tippet & Wood, of Philipsburg, N. J., expressing regret that they could not be present at the meeting, and asking permission to exhibit photographs of their work, and stating that they would be very certain to join the Association as associate members before the close of the year.

It was moved and seconded that the request be referred to the executive committee with power to act. Carried.

Mr. Diven moved that the matter of dropping from the roll the names of members in arrears for dues for four years be referred to the executive committee with power to act.

The motion was seconded and carried.

Mr. Diven moved that the President appoint a committee on nomination of officers for ensuing year, to report at the meeting Thursday afternoon. Seconded and carried.

The President appointed as such committee, Messrs. L. H. Gardner, H. W. Ayres, Jno. W. Henion, W. G. Richards, Wm. Ryle and R. Holme, Jr.

In the absence of the author the Secretary read the following paper:

QUINDARO SETTLING BASINS AND SIPHON WELL.

BY R. C. PEARSONS, C. E., KANSAS CITY, MO.

The intent of this paper is rather to describe the mode of construction of the Basins and their adjuncts, than as a discussion of the principles on which they were designed. A concise review of these will, however, assist in a proper understanding of the work.

The Kansas City water works took their first supply from the Kaw River. The unexpectedly rapid growth of the city requiring additional plant and rendering the first location objec-

tionable on account of pollution of the water supply, it became necessary to choose a new location, which the Water Company, in deference to public opinion, determined should be on the Missouri River.

The Chief Engineer, G. W. Pearsons, advised tunnelling under the Missouri River and taking the supply from a point opposite the upper part of the City of Wyandotte. This would have placed the supply station within a mile of the city, and in sight of the projected high service pumping station. Eventually resulting in these stations being the only ones needed.

The commission of engineers appointed by the Water Works Company passed this project almost without comment and chose the present location.

Work beginning almost immediately it left no time to make surveys and estimates. Actual operations were at once begun on the ground chosen. Some ravines were adjacent to the grounds, one of which might possibly have been utilized, instead of building the basins where they are. This ravine, however, is bordered by farms, of which it forms the natural drainage, and would necessitate extensive land purchase and showed difficulty in providing drainage for the land and waste to the river. There was no time for full surveys and studies required to determine the relative values of the two sites. The present location was chosen, practically by its apparent advantages as regarded ease and rapidity of construction, accessibility and convenient drainage to the river. As soon as the surveys had advanced sufficiently to give data for construction, the work was commenced by building the coal house, which would answer the purpose of boarding house, shop and general headquarters, during the work. The nearest town, Quindaro, being about one and one-half miles distant, such headquarters were necessary. Ground was broken on the 22nd day of April, 1886.

Work on the inlet crib, siphon line and the drains for the basin being dependent on the stage of the water in the river, the basins were started first. The earliest work was the laying of the drain pipe, inlet and outlet pipes, that go under the banks, in trenches in the natural soil.

These trenches had grooves or locks cut in the sides to avoid straight lines. All the bell holes under the bank were excavated to a depth of one foot below the pipe and three feet back of the joint and refilled with concrete up to the top of the pipe, care being taken to fill the hole full and allow no space under the pipe. This was not so much for the purpose of support, as to form a dam to prevent a stream of water from following the pipe.

The drain pipe was (24) inches in diameter, and a branch led to the center of each basin. This pipe was of cast iron and terminated at a point ten feet above low water mark at the river to permit cleaning at nearly all times of the year. This pipe was laid to a grade of eight inches in one hundred feet.

RESERVOIRS.

The form of these was decided by the ground requirements to leave room for switch track, pipe lines, buildings and least practicle volume of embankment for given capacity. Being in the form of a horse shoe, straight on the east side to provide for extensions.

The embankments were commenced by clearing away from six to ten inches of surface dirt until gumbo was reached. This dirt as well as the stripping of the whole ground, was placed in the outer edged of the embankment and clay brought from the hill for the inside. This filling was all put on in from six to eight inch layers, carefully dragged and rolled with a roller weighing one thousand pounds to the foot.

The basins were excavated to a grade two feet below the finished grade and refilled with clay in the same manner that the embankment was made, and finished with a layer of concrete three inches thick and plastered. One foot of extra thickness was allowed in the embankment for trimming slopes.

The inner slope is finished to an inclination of two to one Outside one and one-half to one, that being the outer slope of the old basins which have stood well. This will be discussed further under the head of "failure."

WALLS.

The rock used was native limestone, irregular in form and with very rough beds, making expensive work. No large stone were used, all being set by hand, and nothing too large for setting that way was brought on the grounds. The stone for the face of the walls was cut to close joints and laid as broken ashlar, the walls filled with rubble and concrete. No filling with spawls was allowed excepting where they were driven into joints previously filled with mortar. The beds for stone in this filling were made more frequently with a shovel than with a trowel, leaving no room for grant and making an absolutely tight wall. The bonding of all the walls was carefully looked to throughout the whole work, although no thorough stones were allowed.

There were given two forms of wall for the two purposes.

First, the ice or wash wall. This is around the bank on the inside at top. This wall is on a foundation of concrete six feet wide and one foot thick. It is four feet thick on the bottom, twenty inches on top and is eight feet high The dimensions of the embankment is seventy-six (76) feet on the bottom, thirteen and one-half (13½) feet on top and twenty-two (22) feet high. The purpose of this wall is to prevent the bank being washed by the water, and torn up by ice and crawfish. It extends completely around the circular part of the embankment and along the north and south tangents.

Second. The partition walls, which are altogether about eighteen hundred feet in length, and have a cross-section of one hundred and forty-three feet. It extends across the east side of the basins, forming the inside of the east bank, and form the partitions between the different compartments. It is of the following general dimensions: Twelve feet thick on bottom, seven on top and twenty-two feet high, and has two

CONDUITS.

These conduits are situated one above the other, and continue through the whole length of these walls. They are of the uniform size of six feet three inches high, and three feet wide. They are for the purpose of distributing the water in the different compartments.

The water is, in all cases, drawn from the surface to the

top conduit through eight twenty-four inch openings, and distributed from the bottom conduit through a like number of openings eighteen by forty-eight inches.

These conduits were covered with three inch matched hard pine, every third piece being spiked to a four by four inch longitudinal stringer bedded in the wall. The other two pieces were cut shorter to irregular lengths to provide for bond. These were covered with four by four and four by six inch elm, placed about four inches apart, to add to the carrying strength. This planking was intended to be laid loose and green, and was kept in close piles to prevent seasoning. This will be discussed further under the head of failure.

GATES.

Gates and valves are placed in the conduits and between them, to control the flow so that any one or more basins may be emptied, for the purpose of cleaning or repairing, without interfering with the circulation in the other basins. In the conduits, and between the upper and lower ones the gates are the full size of the conduits, that is six feet three inches by three feet, and are operated from the top of the wall.

INLET.

This is a thirty-six inch pipe and connects directly with the center of the center basin, but can be changed so as to flow into the upper conduit, this is necessary when cleaning the center basin. The water on entering the center basin comes through a spreading box and overflows, this is to avoid current. When flowing one million gallons per hour none is preceptible.

MODE OF SUBSIDENCE.

The water leaves the center basin, over a weir one hundred feet long, into the eight openings into the upper conduit in the east wall, (this weir is for the purpose of aireating the water) from here it passes north through the upper conduit to the center of the east side of the north basin, where it descends to the lower conduit and flows into the bottom of the north basin, passing across the basin in flows out at the top into upper conduit of the wall, between the north and west basins, descending again at the center of this wall into the lower conduit, it is distributed in the west basin, leaving that basin in the same manner and passing through the south basin into the upper conduit in the east wall, it flows south to the end of the wall where it connects with the thirty-six inch flow line to Kansas City, about three and one half miles.

The flow line in these basins is forty-eight feet above the city datum; the receiving tank at Kaw Point is twenty-four feet above the same datum at its bottom.

BOTTOM OF BASINS.

The conduits and gates enable the engineer to throw out any basin without interfering with the action of the rest, and so we can get to the bottom of them, which are built with grades varying from three to ten per cent., the heaviest being in the

center basin, which receives ninety per cent. of the sediment. This basin will require cleaning once from every one to two months, being governed by the character of the water in the river. The slopes are all toward the center where the ends of the twenty four inch drain pipes terminate with valves. The south basin would probably not have to be cleaned oftener than once in from four to five years, so far as mud is concerned, to add to the carrying strength.

SIPHON WELL.

The siphon well is situated in the center of the pump house. It is twenty-five feet interior diameter and twenty feet deep below the bottom of the pumps. It is an iron shell thirty feet in diameter and lined with a thirty-inch brick wall, resting on a floor supported by forty-eight cast iron brackets. This was sunk through sand the action of which was partially as a quicksand which would permit no excavation after getting below the surface of the water, unless it was kept submerged. In sinking it, first the excavation for the building was made to its full depth, the iron shell then being set up in place, and lined with the brick, four twelve by twelve-inch timbers crossing it in the middle, arranged for bracing and also for a floor at half its height. Excavation then begun inside hoisting out over the top, after going about three feet water was struck in such quantities as to require the aid of an ejector to keep it out, with help of this the well was sunk about seven feet further At that point the sand came in with the water as fast as it could be taken out. The ejector was then abandoned and a jet siphon, using a three-quarter inch stream of water, was used to pump sand and water together into boxes placed inside the well, permitting the water to fall back into the well. In this manner the excavating proceeded at the rate of about two cubic feet per minute.

The bottom was put in by a diver, and was of two by twelve-inch plank placed on edge and spiked together. This made a solid floor twelve inches thick with the edges under the edges of the curb, and held down in the center by posts to the floor timbers.

The diver, Mr. Wm. Owens, of St. Louis, a man of wonderful mechanical skill when working under muddy water and with heavy mittens, was killed while wrecking a barge in the Mississippi river last summer. His loss will be a hard one to replace on that kind of work.

BUILDINGS.

The basement of the pump house was sunk to a depth of thirteen feet and filled back with three feet of concrete, surrounding the well and under the engine and building foundations. This building is of stone and brick and finished with gavanized iron cornice and trimmings. It is eighty-six feet square. The foundation walls are seven feet thick at the bottom and four feet thick above the ground, rising five feet above ground, the balance is of brick. The boiler house is twenty-four feet north of the pump house. It has a foundation of stone, rising to the same level of the pump house, balance of building is of brick.

SIPHON TUNNEL.

The siphon tunnel is one hundred and ten feet long. Begins at the north side of the pump house and extends north, passing under the boiler house, making the siphon pipe accessible at all times. This tunnel is eight feet wide at the spring of the arch, five feet wide on the bottom and nine feet high in the center, and is built entirely of concrete.

RIVER CRIB.

Work on this was commenced by driving a row of piles in the form of a bow, the ends resting on the shore. These piles were driven through the woven willow mattress which had been put in by the Government for the protection of the bottom land. It is constructed by weaving by hand willows; this is woven continuously and sunk into place by loading with rock. Two rows of piles were driven from the center of this bow to the shore. Between these piles bed timbers were fitted to the bottom and sunk to place by the aid of a diver. The crib was built of eight by sixteen inch oak and hard pine, then sunk and bolted on to them with fifty wrought iron bolts driven with a musket. This useful tool is made with a piece of gas pipe and a rod of heavy round iron shod on the end with a piece of steel. Piles were then driven above and below the crib for the foundation of the stone pier and for protection of the crib. Between the outside rows of piles was filled with concrete in bags, from there to the shore filled with rock. This pier was sixteen by thirty-six feet, and twenty-four feet high, and had a well in the center seven by ten feet containing screens and gates, allowing water to be drawn at any height desired. It stands fifty feet from shore in twelve feet of water. It is connected to the shore by an iron foot bridge ninety feet long. This is above high water. The well in the pier communicates with the river, its whole height guarded by eight by twelve oak timbers eight inches apart, with eight by eight inch oak behind the openings, preventing timber floating horizontally entering the well.

SIPHON.

The river end of the siphon is of wrought iron, seventy-five feet long, built in three pieces and joined with cast iron flanges. The end which enters the crib is five feet wide and thirty-two inches high. The shore end is provided with a man hole and joins the forty-two inch cast iron pipe by a bowl.

On account of the bad ground and necessity of planking the bottom of the trench, the rise is mostly at the river, the rest of the line rising two inches in one hundred feet. Passing through the tunnel to the well it descends to within eighteen inches of the bottom in two thirty-six inch branches, one just inside, the other in the center. The lower end of these branches are ten feet below low water mark.

The object of two down pipes is to be able, if found desirable, to separate the sand which would drop to the bottom of the pipe on its way to the well by it descent through the first pipe into a compartment under water from which it may be removed. The value of the siphon with valve is to graduate the water flow, guard the basement from being flooded in high water,

and relieve the pumps from the pulsation in a long and large suction pipe; also a less cost in not having to go so deep with the pipe and trench.

MACHINERY.

There are two engines of twelve million gallons capacity each, designed by G. W. Pearsons, and built by the Holly Manufacturing Company. The engines are horizontal compound condensing, driving four vertical single acting vertical pumps each, plungers twenty-five feet in diameter, with four feet stroke, The engines have Hill's pat nt surface condenser. These pumps are arranged to pump from the river into the basins, or to the city, or from the basins to the city, as desired. They are heavy and have large surplus power. No test has been made for duty, but from their action it is estimated at about eighty millions.

There are three horizontal tubular boilers sixty-six inches in diameter and eighteen feet high, set with Murphy patent furnace. There is a Knowles pump (high service) in the basement for fire service and cleaning the basins.

FAILURES.

Two failures have occurred on this work, which are de-described for the purpose of helping others to guard against similar ones.

First. The outside of the embankment, with a slope of one and one-half to one, commenced slipping soon after frost set in, mostly in thin layers outside, but in one place so extensively as to require the lowering of the water in the basins. This occurred over a low spot in the ground which proved to be soft. The shape of the bank after the slip is shown on drawing.

A row of piles was driven all around the outside of slip across the soft ground to form a footing, and preparations were made to change the slope from one and one-half to one to two to one, and to put in drains, it being evident that the ground was different in character from that at Kansas City. No leakage appeared anywhere about the embankment, but it seems that the earth retains water and becomes mobile when frost checks evaporation on the surface. We have since learned that railroad embankments in Kansas showed the same characteristics, have also learned that other reservoirs have required similar change.

The other failure was of the partition wall between the center and south basins. These walls were designed with a safety factor of two This wall was overturned at the bottom of the bottom culvert as if on a hinge, the foundation and lower portion of the wall remaining intact, and no rubbish or debris left on it at all; the wall from the north side of the conduit being carried clear across and deposited with the rest of the wall. When the basins were being filled the center basin had about ten feet more water than the balance, when a crack occurred in this wall the water was immediately reduced to a level in all the basins and the engineer instructed not to let this difference recur, he did, however, and the wall overturned.

About sixty feet of this wall was on a circle of seventy-five feet radius. The conduits in these walls were covered with three inch plank as before described. A study of the effect of the swelling of the plank based on a movement in the east wall

from the same cause, showed that the effect joined with the water pressure, was sufficient to explain the accident. Cast iron plates were studied for the curved portions of the walls, but rejected on account of expense. If the wall had remained till now this pressure could have been cheaply and easily removed.

CEMENT.

The cement used was Milwaukee, Kansas, Utica and German Portland. The use of Kansas cement was based on a series of tests extending over some two years. That of the Milwaukee on its great local reputation, and of the Utica to fill in space when it was hard to obtain the others. When the Milwaukee was obtained its local reputation, and there being some fifty masons idle for the want of it, led to its immediate use without testing. Some of this cement was bad. The Kansas cement was uniform and of good quality, as out of about one hundred car loads no poor cement was found. The Utica cement seemed to make good work although unusually slow in setting and the masons did not seem to like it. The Portland was used in the top of the wall where the sides of the conduits was thin, and about the flow line on the walls where exposed to the action of the frost. The sand used was Kaw river, sharp, coarse and clean. The proportions used were two and one half and three parts of sand to one of cement by bulk.

The broken wall showed no indication of poor cement, so that it is improbable that it could in any way be blamed for the failure. It shows necessity, however, for continual tests of any cement, no matter what its reputation may be.

An opportunity being given for volunteer papers or remarks, Mr. Denman addressed the Association as follows:

MR. CHAIRMAN AND GENTLEMEN:—We have here what we will call "The Kansas City Question." I am not from Kansas City, but inasmuch as opportunity offers, I will try to interest some of you in it. I have clipped from a Kansas City newspaper a decision of Judge Gill in regard to the rights of plumbers. To our associate members, perhaps, this question has not much interest, but to those of us who are daily in contact with plumbers it has a very lively interest.

The Kansas City *Times* announced the decision with a heavily leaded heading, "No Permit Needed. Judge Gill's Decision in the Water Works Case. He holds that Plumbers may tap water mains without a permit from the Company. Major Jones thinks an injunction will yet be granted." I hoped that Major Jones would be here that he might listen to what some of his neighbors thought of the Kansas City Question. Judge Gill presides over one of the lower courts, and this question has not yet reached its final determination.

In the first place, the newspaper heading is misleading. Judge Gill does not decide that plumbers may tap water mains without permit. He does not even enter upon the question of the right to tap the water mains. I will read

JUDGE GILL'S DECISION.

The National Waterworks Company, plaintiff,
vs.
Scheier Bros.. defendants.

This is an injunction suit brought by the plaintiff waterworks company against the defendant Scheier Bros., plumbers of the city, whereby it is sought to enjoin the defendant from the doing of plumbing or other work of any kind which in any way connects, or may connect, with the water supply as furnished by the plaintiff, without having first obtained from the plaintiff a license for the doing such work, etc.

On the application for a temporary injunction, by means of an elaborate answer by the defendants. numerous affidavits and very full and able arguments by counsel on both sides, the merits of the controversy are pretty fully before the court.

The waterworks company, in the pursuit of its contract obligations with the City of Kansas to furnish at all times water for the extinguishing of fires and for private use by the inhabitants of the city, has promulgated certain prescribed rules and regulations for all plumbing works and material to be done and used in and about the entire system which has to do with the distribution of water about the city. Among such rules appears the following:

First—"No plumber shall do work in connection with the introduction of water into any premises, or alter or extend any water service, except he be licensed and under bond."

The license here referred to is a license from the water company and the bond, as well, is one to be made to the water company.

As a condition precedent to this license from the water company to the plumber, the company exacts of the plumber that he sign an agreement in writing binding himself to conform to and obey in every particular all the rules and regulations of the water company. And to secure performance of this agreement the water company further requires of the plumber a bond in the penal sum of $500, with good and sufficient security, payable to the water company. In case of violation of any of the rules of the water company it is provided that at the discretion of the company a fine of not less than $3 nor more than $10 may be imposed on the plumber for each and every infraction of a rule in addition to a charge of not less than $1 for each additional trip made by the company's inspector on account of such violation of rules, and besides may, at the discretion of the company, suffer a forfeiture of his license. In addition to these rules it is further required of the plumber, so licensed by the company, that in making extensions or improvements in private premises the plumber shall before doing such work procure a permit from the company and when the work is done then the plumber within

twenty-four hours shall report the same in detail to the company.

The defendants, Scheier Bros., are plumbers plying their trade in this city and duly licensed by the municipal authorities and have given bond as required by the ordinances of said city, but they refuse to make the agreement and bond exacted by the water company and thereby to procure the license of the company and refuse to abide by the rule requiring a permit from the company for each and every job of work to be done on the premises of those individuals who may employ them to do plumbing work.

The question is: Are the defendants justified in this refusal? Should they be permitted to prosecute their work in the face of these rules of the water company when they have no license from the company to do plumbing work?

We are aided but little by precedents in the decision of this controversy. I am satisfied that if there were such the well-known industry and ability of the counsel engaged in this case would have produced them at the hearing. Considering the character of the business in which the plaintiff water company is engaged, the importance of its work, as well to the public at large as to the individual convenience and safety of all concerned, it is entirely proper and just that it should have the right to adopt and enforce all reasonable rules and regulations for the same.

As to what is reasonable is largely dependent upon the circumstances in each particular instance. The great importance of the engagements of the plaintiff as being carried on in city entitle it to a liberal interpretation of the rule, and I take it that the courts will not be justified in condemning these rules and regulations unless they clearly conflict with private rights. The undertaking of the plaintiff to extinguish fires at any point along the vast lines of its vast net work of water mains by means of the hose attachment, supplied with necessary force from direct pressure, demands great care and circumspection by it in every detail of the work. Nothing unreasonable then is found in the water company following out every attachment for the conveyance of water from its main pipes and inspecting the character of materials used as well as the work done. It would seem, too, that it is not unreasonable that before any particular plumbing or extension is made the water company should have timely notice, and, when completed, that the plumber should report immediately the same to the company. By this advice in advance of work done or of what is about to be done, the company is enabled to witness its progress if desirable and have the same thoroughly inspected when reported finished, thereby insuring to the satisfaction of the company a good and safe quality of work and protecting it from unfair extensions of pipes, whereby water will be conveyed into premises owned by non-paying consumers.

But the water company has, in assuming to exclude all plumbers from doing any work in connection with the introduction of water into private houses unless licensed by it and under bond as hereinbefore stated, exceeded, I think, the bounds of the reasonable. The city of Kansas has the power (and has exercised it) to license trades, and by an ordinance passed for that purpose has provided for licensing plumbers. Under that ordinance a plumber showing himself reasonably skillful and

giving bond in the sum of $1,500 is licensed by the city and authorized thereby to prosecute his calling within the city. Now to give effect to this rule of the waterworks company the license thus granted by the city of Kansas gives no warrant for prosecuting the business of plumbing in this city in so far as it has to do with work that is or may be connected with the distribution of water from the mains of the plaintiff.

Should a like rule be adopted by the gas company, and a license and bond there be required before being permitted to fix gas pipes in private premises, then indeed would the legislative grant of licensing this trade, which was reposed in the City of Kansas, become a power to be exercised by these private corporations rather than the city. In so far as the pipes in the street are concerned and which belong to the water company, it rests its own discretion to employ whomsoever it may, and to exact any contract or bond which may be agreed upon, but as the plumbing work on private premises and which is the individual property of the owner, it would be a harsh, arbitrary and unreasonable rule that would refuse a competent and skillful plumber, clothed with a license from the city, with a bond as required by the ordinance, the right to do such work on an engagement with the owner. This would not only be taking from the license (the plumber) his acquired rights to engage in his vocation in the city, but it might result in subjecting the individual owners of private premises to ruinous monopoly. There is nothing in this case to justify the suspicion even that the present managers of the water company would, through this licensing, organize or encourage any such a monopoly. The vice in the rule is the means it provides for such an end.

Another rule, heretofore referred to, is also subject to criticism It provides that for every violation of any rule the water company, "at its discretion," may impose a fine from $3 to $10 dollars, and besides may impose a charge of not less than $1 for each trip made by the inspector of the company on account of such violation of rules.

It may well be said of this rule, as was said by the Wisconsin Supreme Court in Shepard vs. Milwaukee gas company, reported in 6 Wis., 519. "This summary jurisdiction would not be given to any of the courts in any case but upon the most urgent emergency."

These defendants, these plumbers, are called upon before being permitted to conduct their trade in connection with the water service to agree to abide this rule and give bond with approved security to answer such an obligation, to wit, that in case they violate any of the rules of the company they will pay such penalties as may be fixed within the above limits at the discretion of the company and pay, too, any sum fixed by the boundless discretion of the company from $1 up, without a maximum limit, for every trip that may be made by the inspector of the company to view the work.

While then conceding to the water company authority to enforce all reasonable rules and regulations as to the plumbing work which may connect with its water mains, it seems there is good cause to claim that the rules last referred to are unreasonable, unjust, arbitrary and oppressive and such as the courts ought not to assist in enforcing. As already said it is entirely reasonable that the company should inspect and determine the

quality of work done which connects with its system, and if such as to endanger its successful operation that the company would be justified in refusing to turn on the water. But it would be exercising those functions which belong to the municipal government when assuming arbitrarily to determine who should follow the plumbing business. No complaint is made as to the skill or competency of the Scheier Bros. They are duly licensed by the city, and are entitled to follow their trade without further authority from the water company.

The injunction asked therefore will be denied.

I sent a copy of this decision to one of our prominent attorneys with a request that he make such comments upon it as he saw fit, of which I leave you to judge. He says:

A fair examination of the decision of Judge Gill shows that the following propositions are sustained thereby:

1st. The Water Company has the right to make and enforce reasonable rules with respect to water connections.

2nd. Such rules may go to the extent of denying plumbers or others the right to make actual connection with the mains of the Company or with connecting pipes without notice to the Company and opportunity given to inspect the work into which the water is about to be introduced.

3rd. The Company may also require a report of the new work or extensions from the plumber, that they may know the extent and character of the additional service required.

4th That if the new work is not properly done the Company may prohibit the turning on of water until it is properly done.

On the other hand it is also held by Judge Gill that any plumber, whether having a permit or not, may put in the new work, not including, however, the turning on the water or making the actual connection.

The decision will fairly bear the construction that no one not having a permit from the Company may make the connection or turn on the water.

The very point decided by the Judge is this: The rule adopted by the Company in this case was too broad in that it prohibited the doing of *any work* by a plumber not having a permit, which was constructed with a view to a connection with the water system of the Company.

The dividing line of the opinion as to what may or may not be done without a permit is just this:

A plumber or other person possessing the requisite skill may put in the new work without a permit. He may not connect the new work with the old or turn on water without such permit. Such permit may be withheld until report of the new work is made and reasonable time given for inspection.

The opinion is not clear on some other points: May the plumber be required to give bond that he will use proper material; make correct report of new work done, and make connection and turn on water only after inspection duly made and permit granted.

The opinion leaves the mind in doubt upon these points, with a strong intimation that bond cannot be required.

The third point in this comment may be very true, so far as it goes, but I presume you will all concur with me in the statement that it would be impossible to run a water company under such a rule. He says that the plumber has no right to connect with the pipe; he has no right even to extend a pipe after it is connected. But suppose he does? A plumber's apprentice who has acquired a little skill may extend a pipe into an adjoining room; may furnish a bath room with water; may supply another family, and what remedy have we? It is true Judge Gill says he has no right to do so; but suppose he does? It drives us to the common law, and then we have to prove our damages at a cost for retainer alone of from ten to twenty-five or fifty dollars to prove claims to the amount of five or ten dollars, perhaps.

Here is a very much shorter opinion from another attorney of high repute.:

"I conclude from a hasty reading of the opinion—

"1st. That the judge was about right in his opinion.

"2nd. He held that water companies have the right to pass and enforce reasonable rules for the protection of their system of water supply; that they may refuse to turn on water until these are complied with. If extensions are made they cannot be connected until the company are notified and approve the same. This, it seems to me, is all the Water Company want.

"3rd. He says the rule of the K. C. Water Company is too broad in that it violates the ordinance of the city duly passed for licensing plumbers. A water company cannot by rule repeal a statute of the State.

"4th. The Court, I think, will never hold that any one can either tap the mains or add to service pipes without notice to the company."

I turn to the rules and regulations of the Kansas City Water Works, and find that they are acting under an ordinance which very fully protects them from anybody who undertakes to use water for purposes other than those specified in the license and permit. It is made the duty of policemen, when on duty, to report to the Chief any violation of this ordinance, and especially as to the use of fire hydrants. They seem to be fully protected. But the Kansas City authorities have given them no right to require either a permit or a bond; they have given them no right to impose any penalties, and these rights, it seems to me, might well be delegated to the water company.

Furthermore, it has occurred to me that the Kansas City Company would have been more successful had they asked for an injunction, not against the plumber, but against the owner, whose agent the plumber is. The owner himself is responsible for any additional fixtures

that may be placed upon his premises without a permit from the company or application by him. But I do not see how the spirit of this ruling can be successfully carried out. If water companies were to be placed upon the same basis as commercial men it might do very well. If it were a fact that a water company could protect its goods as a grocer or dry goods man protects his goods; if consumers came to the counter, got their measure and carried it away, it might do very well. But, inasmuch as water companies are required by ordinance to extend their pipes wherever directed, to permit all citizens to use water at their own will and without the presence of the company or its agent, it seems to me that, in the interests of justice, it requires a peculiar rule. That same principle has often been thrown up to me in the use of meters. A man says, "Why, I go to a grocery store and the grocer uses a measure; but he don't charge me for the measure. What right have you to charge me for the meter?" Why, simply on this principle: That the meter is for your use exclusively, while the grocer measures his potatoes out of a common measure for the whole public. It seems to me that that answers the whole question.

Within a few days our inspector went into a building and found there three water connections which he knew were not upon the bill, and he knew that the parties were not paying for the water. He asked how long they had been there. He discovered that they had been there about five months. "Well, who did it?" "I don't know." "Why, didn't you have it done?" "Yes, I had it done." "Well, who did it? You had it done and don't know who did it?" "Well, I don't know who did it. I don't know the man's name. I know him by sight, but I don't know who did it. I paid him for his work when it was done, and did not inquire his name at all." Now, what protection have water works companies from such men?

MR. LAKIN:—Does not your city ordinance give you the right to compel the consumer himself to make application to make changes? And if it did, would not that cover this case?

MR. DENMAN:—The ordinance ought to.

MR. DUNHAM:—I would like to ask if in this particular case you did not have any recourse upon the owner?

MR. DENMAN:—No, it is not quite old enough, and then, as I said before, all the remedy we have against him

is the common law, and the whole bill, if it had been paid for the entire year, would amount to perhaps nine dollars, and we would have to pay our lawyer twenty-five I suppose.

MR. W. G. RICHARDS:—If this party had violated an established rule of your water works, could you not have had recourse to your curbstone cock to shut the water off?

MR. DENMAN:—Oh, yes, we often do that; but suppose they have recourse to the curbstone cock and turn it on?

MR. RICHARDS:—Then you have recourse to the law and prosecute them.

MR. DENMAN:—Yes, and the same twenty-five dollars comes in again.

MR. RICHARDS:—They become responsible then in the police court.

MR. DENMAN:—Yes, if the law was so fixed; but it is not.

MR. DUNHAM:—I would like to ask Mr. Denman if the same thing is not true when a man steals an overcoat or hat?

MR. DENMAN:—I don't know about that. There seems to be a different code of morals touching the stealing of water from that which prevails in regard to the stealing of anything else. We had a little discussion last year as to property in water, and as to what the law said was property in water. I commend that pamphlet to Mr. Dunham's attention. But you would be laughed out of police court. If here were a person who had taken water that he did not pay for, amounting to two or three dollars' worth, and you should arrest him, you would not dare go before the public in such a case in the present temper of the people.

MR. BABCOCK:—Would it be possible to make a special rate in such a case, to cover the cost of litigation? Suppose you establish a special rate, say a hundred dollars for the use of a bath tub, under such circumstances. You certainly then would be protected, would you not?

MR. DENMAN:—No, sir; our rates are all established by the city. We have no right to impose any penalty.

MR. TUBBS:—Mr. President, I do not desire to interrupt the gentleman very much, although he takes very

kindly to questions. I am myself managing a water works company. It strikes me that you have already suggested the remedy. I think that Judge Gill, or any other judge, would uphold any set of regulations which seemed to be reasonable and seemed to be arranged specifically for the protection of the works, for the general public good as well as for the good of the company. I suppose, so far as I am informed, that there could be no objection raised by the courts or anyone else to a requirement, if it should be made in the rules and regulations, that the consumer or the proposed consumer should come and sign a contract with the company for the use of the water—not only the use of it, but the putting it in, under such fair and reasonable regulations as would protect both the interests of the company and those of the public; then hold the consumer or proposed consumer responsible for doing exactly as he agrees in his written contract to do. I will say, incidentally, also, that I do not believe that any plumber should be allowed to tap a main unless he is a paid employe of the company itself. I think that work should always be done by the company. Then, to a certain extent, it controls the situation. The other suggestion which was made by yourself it seems to me would very largely cover the ground.

Mr. Denman: We have no trouble in controlling our taps—none whatever. We do not do the tapping ourselves, but we authorize it to be done by one trusty man, a plumber, who was nominated at our request by the Plumbers' Association. He is a trusty man, and as I have said, we have no trouble in the matter of tapping. Our trouble arises from the extensions. As to the consumer, he is not always a property owner, and is very frequently quite irresponsible. This I believe, is the first recorded decision in regard to the relations of Water Companies with plumbers. It is of interest on that account. I shall watch the final settlement of it with a great deal of interest.

Mr. Burke, of the Local Committee, invited the members of the Association to take a carriage ride on Friday morning, to visit the Lake Shore Foundry and the Pumping Station and Fairmount Reservoir.

The invitation was accepted.

A paper by Mr. Samuel McElroy on reservoirs was read by title.

A motion was made and seconded that the reading of the paper be dispensed with, and that it be printed in the proceedings. Carried.

RESERVOIRS.

BY SAMUEL McELROY, C. E.

In an eminently practical association like this, composed of thoughtful men who are constantly in contact with the various problems of water supply, use and disposal, and in a country like this, where the growth of population is systematic and often phenomenal, and a generation cannot, in any case, leave off as it began, every prominent question of practice merits the most careful study.

The subject named covers various interesting and important methods of practice, which cannot be discussed in a single paper, and merit, each for itself, special examination. In fact the entire question of reservoir use is at issue by parties of great persistance in their special theory, who urge a direct mechanical supply, without reserve, as the more economical and efficient system, and substitute the contingencies of a boiler and engine room, or a turbine wheel house for the positive safeguard of adequate storage at high levels, in opposition to the experience of all time in the profession. But experience comes in to check this error with great emphasis at times, and serious losses by fire united to obvious objections in use and control of supply, sanitary and otherwise, cannot be properly ignored. Economy in water supply outlay, with a due regard to future demands, is wisdom; parsimony in obvious safeguards is dangerous for both present and future, especially in view of the liberal annual returns collected for water supply and the reduction in fire insurance rates.

Reservoirs have various uses, as on the Mississippi, the Monongahela branch of the Ohio, and in various other river valleys, they may be used to promote navigation and reduce floods. In one country this is becoming an important duty of hydraulic engineers, as on the Merrimac and various other streams they regulate mill supply in spring and fall. As on the Erie, Black River, and other canals, they maintain navigation.

In city supply, which specially interests us, it may come from lakes, as at Chicago, Cleveland, Detroit, Buffalo; from ponds, as at Boston, the Croton Valley; for Brooklyn and various other cities, from powerful rivers, as for the cities on the Mississippi, Ohio, Hudson and other cases, from various creeks, from underground sources by artesian jets, or from chalk, or gravel, or other underground formations by gravitation or pumping.

In these instances the underground sources are natural reservoirs, as are many ponds and lakes fed by local or distant rain supply, under circumstances adapted to each. The great lakes, like Ontario and Erie, of vast extent, great depth, large inflow and outflow, reversing the usual order, in subsiding when smaller bodies fill up, as in the spring, and rising when other bodies fall as in the early autumn.

Such natural reservoirs as are found in the Croton Basin, are very valuable sources of supply. Lake Mahopac, for instance, formed in rock, with a primitive supply basin of 2.65 square miles, an area of 603 acres, a level of 658 feet above tide, is invaluable to the Croton supply, as are about thirty other lakes of smaller capacity in the same basin, of which fifteen, in 1876,

covered about 2100 acres. Their clear, pure and cold water proves of great service when the Croton river and lake are in a state of fermentation.

The supply from natural underground sources, if not impregnated with lime or other minerals, is valuable from its filtration and depuration. Long Island is an illustration of an enormous storage reservior in gravel and sand, of pure and cold water, sloping back from tide, about eight feet per mile, receiving and discharging an average of not less than 1,200,000 gallons per square mile daily. In this case the rain passes vertically downward through a fine sand and close gravel formation until it reaches a water bed of coarse gravel layers, through which it flows towards the sea.

Large rivers furnish a valuable supply in quantity and quality as a rule. The Missouri and Mississippi, in the clay solution, which are, at times, an annoyance in quantity, yet depurate their contents from organic matter and its evils by this means to an important extent.

It is fashionable at present to decry river supply, but much of the objection really existing is due to want of care in use and management. Men of genius, like Frederick Graff, the father of the Schuylkill supply, can meet unusual difficulties by simple and effective means, and the methods deserve close study. On a comparatively small river, like the Schuylkill, the time may come when the pollutions accumulate too fast for any remedy, and a better source must be sought by a city grown rich enough to afford the change: but the sanitary department of supply and use has been much neglected in various prominent instances, and simple remedies neglected.

In connection with this rapid sketch of the various kinds and use of supply reservoirs, as lakes, rivers, creeks, artesian and underground for control of navigation, floods, mill supply and city use, various questions arise, which we can only name here.

Our hydraulic records and literature are still conflicting and indefinite as to measurement of rainfall and snow, percentage of catchments at different levels, rates and proportions of flow from forest, uncultivated and improved areas, loss and gain by evaporation and condensation, effects of formation, wave wash, absorption, filtration, leakage, waste-weir section, floods, ruptures, contamination, fermentation, depuration and other conditions and contingencies.

Passing these as proper subjects for society examination, I propose to discuss chiefly two important questions of construction and use of service reservoirs, which impressed themselves strongly on my mind when engaged, more than thirty years ago, on plans for the Hamilton, Rochester and Brooklyn Water Works.

In one of these cases the supply was limited to pumping from Lake Ontario; in another, to a similar plan, or by gravitation from distant lakes; in the third, to gravitation from a series of mill ponds, supplied from the great underground water bed at a low level, with a pumping supply. Service reservoirs were therefore necessary in each case, to be maintained at a high level in reference to the city, involving questions of location, capacity and detail construction.

As the Brooklyn supply was the most important of these, I will use it for an illustration, as put under contract May 3, 1856, when Chief Engineer of The Nassau Water Company.

The population was then about 210,000, and a supply of 10,000,000 gallons per day, was assuming a very liberal basis of use for that day; and the ratio is not much exceeded now, being about 54 gallons per head.

The only available site for a service reservoir within the city, at a commanding elevation, was Mount Prospect, but the area was limited for a proper reserve for contingencies. It was decided, therefore, as a matter of economy in aqueduct length and pumping lift, to place the main service reservoir about five miles east of the distribution center, where a much larger site was available, and a flat of 48.4 acres was purchased, with adjacent lands suitable for extensions, on which a reservoir of 25.58 acres water surface and 20 feet pondage depth was planned at an elevation of 167 feet above tide, capacity 161,220,000 gallons.

Mount Prospect reservoir was adopted as an auxiliary in the city, with 11-08 acres, 20 feet depth, and 20,000,000 gallons storage, the joint storage being 181,222,000 gallons or about 18 days' supply.

The reserve of New York City at that time was "Murray Hill" reservoir, 21,000,000 gallons, and "Manhattan" 150,000,000, or 171.000,000 for a population of 630,000. This was increased in 1862, by the new reservoir of 1,000,000,000 gallons.

The City of London was then, as in the main it now is, under the *intermittent* system of distribution, each company dividing its supply into districts, but one of which was supplied at a time, and in no case more than once a day, sometimes not more than three times a week; the periods of supply being three-quarters to three hours; the cisterns or other receptacles being usually near street grade, and the flow coming mainly from the engine house stand pipes. This modified the relation of the service reservoirs to the distribution, except for fire service. For a population of 2,157,000, 27 reservoirs in all were in use, with a joint area of about 147 acres; capacity, 216,000,000 gallons; daily supply, 45,000,000. Seven of the nine companies pump by steam.

Philadelphia, from the Schuylkill, had a group of five reservoirs, capacity about 47,000,000 gallons at Fairmount; one at Spring Garden of 9,800,000 gallons; two from Delaware river, 9,284,000; total about 68,000,000 gallons; population in 1855 about 450,000.

It was evident, therefore, that with a location favorable for enlargement of Ridgewood reservoir, unusual provision was made for service reserve, in a case where pumping capacity, up to 30,000,000 gallons per day, was provided for, one engine house, with room for twice this amount, and 3,750,000 gallons per day at Mount Prospect, with room for twice the amount.

Yet, as a lesson of the day on reserve, location and capacity, the population and demand have grown to more than threefold, in what in city life is a very short time, and preliminary steps have been taken, by purchase of additional lands, for reservoir enlargement.

Another question of reservoir sites was determined here. To pump the Mount Prospect supply once into Ridgewood, with 163 feet lift, and again from a 30-inch main into Mount Prospect, involved a special outlay of capital for engine house, engines,

mains and operation, an auxiliary site commanding the upper district not being available at Ridgewood. Such a site could have been supplied from the main engines, but involved an independent distributing main of five miles to its special district, with much greater frictional loss.

Besides this, there was an obvious advantage, for fire purposes, in an auxiliary reservoir within the city; and while, in 1860, it would have been cheaper to pump the entire supply more than 34 feet higher, at Ridgewood, the time would come when increase of demand would make the plan adopted much the most economical.

The question of detail construction for so large a reservoir, was next in order, in a case where economy was a paramount consideration.

A study of careful cross sections taken showed that the pondage basin must be located with the southerly bank along the crest of the ridge, which sloped rapidly to the south and overlooked a populous district. Safety, as well as economy, required a restricted depth to reduce water pressure and cost of lining, while a very shallow depth, exposed to solar action, was inadmissible. Twenty feet was therefore adopted as the standard. Knowledge of wave wash and its contingencies, made it essential for such a bank, to allow not less than 4 feet, giving a total average depth of 24 feet, with a floor dip towards the effluent gate house.

With the best material for earthwork at hand, and a small deposit of clay within the grounds, the pondage lining was the next study; and here there was no question that the practice of the ancient engineers with works in use to-day, and of the best modern examples was in favor of water tight faces.

Of the 27 reservoirs in London, 21 were lined with substantial brick masonry, except occasional cases of small basins with concrete slopes. This plan was adopted at Philadelphia by Mr. Groff, and in other cases; and at Albany, on the Erie Canal, and elsewhere. I had seen the evils of dry stone work too clearly to adopt it here. Yet dry stone protection was the rule of the day, and is very much used yet.

Elevated service reservoirs are always dangerous structures in any locality, and engineers who have had to measure the damages caused by rupture, know how appalling they may some times be. If their safety depends on the proper confinement of a large body of water, which is incessantly at work against its walls, and earth banks are depended on to guard it, it must not be permitted to act on so soluble a structure. The only way to protect an earth reservoir bank or floor is to keep it dry; otherwise pressure, storm wash, motion, leakage, frost or animals may weaken and destroy it. The usual one and a half and one slope is far from being an angle of repose for an earth bank, and to stand water wash it needs to be four or five to one.

Dry work, properly laid, requires much more time for selection and fitting than cement work, for the same section and slope; it requires a better class of stone throughout; and the cost of hydraulic cement mortar, in itself, does not add more than $1.20 per cubic yard, or about the cost of the cement mortar, to that of dry work, for the same stone. At Ridgewood we paid

$1.50 for the dry stone lining, and $2.50 for similar wall in cement with full joints. The repair accounts of dry walls on various public works has been a formidable item.

Experience also shows that a well puddled and brick covered reservoir floor would have prevented some costly bottom leaks and ruptures.

In a Report on the Hudson River and Champlain Canal Improvement, made to the State Engineer of New York, in 1867, I had occasion to show that a solid masonry canal slope wall one third to one, with 4½ feet concrete footing and 30 inch wall could be built and coped for less than the one and a quarter to one dry slope wall, which has been an endless cause of wash, rupture and repair along the entire canal system of the State.

If the experience of our reservoirs similarly lined was properly collected it would certainly end their construction, as it would similar constructions for mill power races, dams and other faces exposed to wash and frost.

For both Brooklyn reservoirs the following specification was adopted:

"The inside slopes to be carefully puddled for two feet in depth, then covered with a substantial layer of cement mortar and gravel (concrete), not less than three inches thick, over which a wall of brick masonry shall be built eight inches thick to the embankment top, and covered with a flag coping not less than three feet wide, by five inches thick. The bottom of the apartments to be similarly puddled and covered with best paving brick laid on their edges and carefully grouted."

In the Ridgewood case this theory was fully confirmed by negative experience. A change in the direction took place in 1856, and some changes in plan in 1857. The slope lining was thus specified:

"The water slopes, unless otherwise directed, to be paved with a well laid stone paving one foot thick, the stone used to be sound and of proper shape to make neat and compact work; and openings between said stone to be well pinned and packed; to be equal in every respect to the receiving reservoir of the Croton work. The paving to be laid on a bed of gravel or small stones."

A considerable length of slope was lined under this specification, under Mr. Kirkwood's personal inspection, as a pattern for the rest; it was as cheap for the sub-contractors to use 15 to 18 inch stone, and the wall was thus laid, with about five inches of small stone backing. When about seven feet of water was pumped into the eastern division in 1858, the wave wash cut the embankment behind the wall so rapidly that the water was drawn down, the injured sections repaired and the entire lining carefully filled in with cement, grout and pointing.

This involved a change in the dry wall of the new Croton reservoir, then under contract, to cement stone masonry. The Mount Prospect reservoir, built according to the original specifications, illustrates to-day its advantages. For convenience of construction, however, it is best to increase the concrete thickness and reduce that of the puddling.

The second prominent feature of Ridgewood reservoir was the provision for depuration by subsidence and decantation.

Reserve capacity, at a commanding level, is not the only great advantage of service reservoirs; and various instances

cited, when great capacity, without proper circulation, becomes an injury to the supply.

As all conduits carry more or less solid matter, a sufficient receiving chamber to allow subsidence is desirable. Impure water being heavier than pure, subsidence is easily had; the surface clarified can then be decanted from one division to another, with the sanitary benefits of circulation and aeration, as Mr. Graff did with the four divisions at Fairmount.

Not only were the engineers of past centuries specially careful to select pure sources of supply, but on various aqueduct lines reservoirs were built at intervals of about four miles, which facilitated repairs and promoted subsidence and aeration. In Turkey the *souterazi* towers, on aqueducts crossing plains, were practically open aerating stand pipes, up and over which the supply passed, and in the *castello* of Rome various chambers received the supply in turn, this was also the case with rain water cisterns.

Fermentation records, in American experience, thirty years ago were not so full as now, but enough was familiar to me then to prove that even so admirably filtered a supply as that of our Long Island ponds, would be improved by proper decantation, and for this purpose the reservoir was planned with three divisions, with three surface decantations and the open air inflow chambers. This was also abondoned in actual construction, and Brooklyn suffers more or less on this account.

The experience of my native city, Albany, may be cited in point. About 1852 it abandoned a small and very valuable gravitation supply, with an expensive covered reservoir, and refusing to pump from such a river as the Hudson, adopted an expensive gravitation supply from a stream exposed to contamination, using large and shallow supply reservoirs without decantation or much circulation. After suffering for a long time from fermentation, resort was made at great cost, to the Hudson, but not above the city front, and without care as to reservoir arrangement; and now another large expenditure is being made for a gang well supply, when it is obvious that the third system is far superior to the others, properly used, and could have been made so, with moderate outlay.

The ancient reservoirs, as a rule, were protected from the sun, and the sanitary advantages of covers are obvious. At Ridgewood or Mount Prospect the areas were too large for any permanent construction of the kind. Wherever the precaution can be adopted it is wise to use it.

It follows from what has been said, that influent chambers with ample time for subsidence, should be provided with proper bottom blow off, for occasional cleansing. In cases of noxious fermentation the process may, at times, with care be confined chiefly to the first division, since water thus affected rapidly sinks, while the surface can deliver a corrected supply to the next division.

It also follows that the effluent gate house should not deliver a bottom supply, as is done now in notable cases, but the outflow should be taken from near the surface by proper screens and passages. If time would permit this might be forcibly illustrated; but enough has been said to present the special theories of construction advocated.

The Secretary read a short paper by Associate Member Richard Beaumont, entitled "Experiments to determine the value of frost jackets in fire hydrants."

On motion, the paper was laid upon the table.

Mr. Decker moved that the rest of the morning session be devoted to "QUESTIONS AND ANSWERS." Seconded and carried.

QUESTION:—"What warrant, based on just treatment of the public at large, is there for making a lesser rate for power for operation of elevators and mechanical uses than for consumption for culinary purposes?"

MR. DUNHAM:—I would like to inquire whether that refers to quantity, and is the rate per thousand gallons?

THE PRESIDENT:—I so understand it.

MR. DUNHAM:—Elevators usually take more water than is used for culinary purposes in the same establishment, and naturally it would be cheaper in an increased quantity.

MR. LAKIN:—I do not know how private corporations would figure that out, but as a city we base those rates upon the fact that we can pump a million gallons more cheaply than we can pump a hundred thousand gallons. If we pump you five thousand gallons of water, we can pump that for you more cheaply than we can pump a barrel—just as you can go to a wholesale house and buy a carload of goods more cheaply than you can a small quantity.

MR. DENMAN:—Mr. Chairman, I suppose that the writer of the question intended it in this way: It is a fact, I believe, that in some cities water is furnished for specific purposes more cheaply than it is furnished for other purposes. I mean the same quantity of water. Water is furnished for elevators, for instance, and for mechanical purposes, more cheaply than it is furnished to railroads, we will suppose, for the sake of illustration. It is furnished for elevators at a cheaper rate than it is furnished to hotels. Of course, I speak now of the same quantities. If a hotel uses a million gallons a month, and an elevator uses the same quantity, we are very apt to concede a reduction in price to the elevator. Now, the question was intended to cover that matter, I presume. Why should we make any difference in the schedule as to the purpose for which the water is used?

MR. RICHARDS:—With us, we have one established rate for all. Every consumer is required to put on a meter

and we have one rate for large and small. It was argued before the Board that as the large consumer was using water by the wholesale, he ought to have it for less than the small consumer. But it was said on the other side that the large consumer was just as well able to pay a certain rate per thousand gallons as the small one. A great many smaller consumers are using it because they are obliged to, for sanitary purposes, etc., and perhaps they are no better able to pay twenty-five cents a thousand than the large consumer would be to pay twelve and a half cents a thousand. So there is just one rate fixed for all. I don't know whether that rule would apply so well to private Water Companies. Ours is a water works owned by the city, and the citizens claim, and perhaps justly, too, that if there are any privileges, the common citizen ought to have them.

MR. TROY:—I will state, as a representative of a private corporation, that we have adopted a sliding scale, so that the large consumer shall pay a less rate than the small consumer. As our friend says, the large consumer is a wholesale dealer, and the retail dealer should pay a little more for it.

MR. TUBBS:—Mr. President, I am one of those who take rather radical grounds on the subject, perhaps. I am inclined to the opinion that the prime motive back of all the laws of the different states granting franchises for water works, or allowing cities to construct them for themselves, is that the citizens should be provided with a sufficient amount of pure, wholesome water for their comfort, for their needs and for their health. It is to conserve these ends. I do not believe that the law contemplates that any municipality should form itself into a hydraulic-canal company for the purpose of furnishing power for manufacturing purposes. It is true that modern convenience and luxury have required the use of elevators. They have required a good many uses of water for various purposes which are not really necessary for conserving the particular purposes for which I think the law was created. Hence, in my opinion, there is no reason why a reduction in price should be made to the manufacturer or to the man who runs an elevator, or for any mechanical purpose. On the contrary, as the theory I have advanced is that it was to conserve the health and comfort of families rather than anything else that the law was created, I am of the opinion that if anyone is to receive the benefit of low rates, it should be the household consumer.

MR. DENMAN:—Mr. Chairman, I have in my hand here meter rates from one of the largest cities of the Union. They are divided into three classes: "General meter rates, 30,000 gallons or less per month, 35 cents per 1,000 gallons. Manufactnring meter rates, 30,000 gallons or less per month, 24½ cents. Elevator and motor rates, 50,000 gallons per month or less, 30 cents." There are three distinct rates. There are a good many companies that do the same. I have myself steadily resisted that kind of thing. We happen to have in our Board of Directors two or three men who are running elevators, and they are anxious to have special rates made for elevators. They have not yet accomplished it, and I doubt very much if they will under the present management; but they have these examples, and one of them has collected perhaps twenty rates from various cities which suit his purposes.

MR. TUBBS:—I omitted to make one suggestion in regard to the matter, and that is, in the making of these laws allowing companies to take water for municipal supplies usually they are allowed to take adversely—to take water from lakes, streams, ponds, etc., even as against the rights of the riparian owner, without making compensation. Now the taking of such a quantity as is required for manufacturing uses, and uses of that character, makes the corporation, whether it is a private company or a municipality, a semi-hydraulic power company, and I think it is doing an injustice to the riparian owner from whom the stream is diverted, as well as to all others concerned, to make that distinction.

MR. DECKER:—Mr. President, I take it from the tenor of the question that it refers particularly to where equal amounts of water are used, but applied to different uses. I am opposed to the theory of making a difference in rate where equal amounts of water are used. I have here a record from a certain city in this country where they make a difference of about twenty-five per cent. between the elevator and the general uses of their hotels. The water is carried in the same pipe to the same point, and certainly at about the same expense, and the uses are nearly the same. For instance, in a certain month I find that four hotels used as follows:

GENERAL USES.

No. 1.—346,000 gallons @ 15 cents	$ 51 90
No. 2.—493,500 " " "	74 00
No. 3.—500,000 " " "	75 00
No. 4.—910,000 " " "	136 00

ELEVATOR.

No. 1.—464,500 gallons	@	12½	cents	$58 95
No. 2.—400,000 "	"	"		50 00
No. 3.—400,000 "	"	"		50 00
No. 4.—388,000 "	"	"		48 50

In nearly all these cases the elevator is using a smaller quantity of water than the house uses, and yet it is furnished at a rate about twenty-five per cent. less than the house service. This may be policy but there certainly is neither justice nor equity in it. Nor do I believe in discriminating between consumers. For instance, a man who is keeping a livery stable may use it for washing his buggies. He may use 25,000 gallons a day and pay a rate of 20 cents per 1000, while his neighbor, who runs a little one-horse power engine, and uses but a small quantity, gets it at 12½ cents per 1000 gallons.

MR. TROY:—We make no difference in regard to the consumer, whether he is a manufacturer, runs an elevotor or uses it for domestic purposes. We meter it to him. If he uses so many thousand or hundred gallons a day, we give it to him at a certain price. If he uses above a certain amount, we give it to him at another price. There is a sliding scale, irrespective of what his business is, whether he is a manufacturer or private consumer.

MR. DUNHAM:—It seems to me that something might be charged for the service rendered. Now, in the instance mentioned by Mr. Decker, if it is of advantage to the livery man to have the water under pressure to wash his carriages, and it is not to the advantage of the man who runs the engine to have the water under pressure in dilivering it to the boiler, it seems as if we might discriminate there. I know of a city where there are two services, a high and a low service. In one there is a pressure of 130 pounds to the square inch, in the other about 40 pounds. They are connected by a regulating pressure valve. Now, in that city they have elevators. They frequently connect an elevator with the high service and discharge into it the low service. The water in that case is not used at all except as a power. It passes through the cylinder of the elevator, and goes directly into the low service to supply consumers, precisely the same as if it went through a pressure valve, and they charge for that service about two thirds, I think, of the amount they would charge if they delivered the water directly to the consumer; and it seems to me there is some reason in it.

QUESTION:—"Where water is sold by meter under a schedule of rates, has a consumer a right to sell to his neighbor without consent of the company?"

MR. DECKER:—No, sir.

MR. LAKIN:—How do you know he has not? Where do you get your right to sell it?

MR. DECKER:—Simply because, if this applies to private companies, in almost all cases the company has a franchise nearly exclusive, under certain conditions and for certain considerations. It receives from the city a right to sell water, which the consumer does not, and in his agreement with the company he (the consumer) agrees to take water for certain purposes and for certain uses only, and does not agree to take it to retail to his neighbors. I think that is the case almost universally.

MR. LAKIN:—I suppose it is all right, but if I was running a private works, it would not make any difference to me where the money came from so long as I received it, where the water ran through a meter.

MR. RICHARDS:—You can very largely overcome that by establishing a minimum rate to each consumer, and even though they should take the water from the same meter or the same service pipe, you could require the payment of this minimum rate from both. That is the plan we have adopted. We allow, for instance, two consumers to run a joint service pipe in and take water through the same meter, but we collect for 5,000 gallons a month, if a man uses but five gallons. That is, we collect from each consumer a minimum rate of 85 cents per month, $10.00 a year.

MR. DECKER:—That is not the intent of the question, as I understand it. Then one party does not sell to the other; the water company does the selling. This question refers to the right of a consumer to sell to a neighbor and receive pay therefor.

MR. DUNHAM:—Mr. President, I think that is perfectly fair, to have a minimum rate for meter service. Then if the water is taken to a neighbor, and both use the meter, let them both pay the minimum rate.

THE PRESIDENT:—I suppose in most cases these matters are regulated by the by-laws and rules of the company. Judging by the discussion, there is very far

from uniformity in these matters about the country, and I suggest that if some one of the members would take this matter into consideration, sum up the general points of rules and regulations in different parts of the country, and give us information about it, we could perhaps bring this down to a more simple and more uniform standard hereafter. Bring together also the main points of the legislative enactments in the different States. Mr. Denman has done something in that line on another question, and given us some very valuable points, and I wish some one might do the same service in this line of fixing rates and rules stating what the general practice is in the different parts of the country, and what the general legislative action has been under which these by-laws are made.

MR. TROY:—I will state for our company that we have adopted a rule that no consumer shall at any time furnish water to any parties unless the parties show a written permit from the company. We make that rule imperative, so that we know exactly where our water is going at all times.

MR. DENMAN:—There is nothing like sticking to the question. It is easy enough to tell how you do it, but that does not answer the question. Has a consumer a right to furnish his neighbor with water, even though he takes his water through a meter? Somebody shakes his head. Now, if I buy a thousand gallons of water it is mine, have n't I a right to with it as I please?

MR. LAKIN:—You bet you have, every time. It is yours; you pay for it.

MR. TROY:—Don't you buy water under certain restrictions from the water company?

MR. DENMAN:—No, not as to what I shall use it for. I agree to pay for it. I may use it for anything I have a mind to, for sprinkling my lawn or my neighbor's lawn, or anything I want to. I have bought it and it is mine, providing I pay for it. Let us go a step farther. We all have schedules of rates. The sense of the meeting, evidently from the discussion of the former question, is that a large consumer ought to get water more cheaply than a small consumer. Suppose a consumer is getting it at a 30 cent rate, and the natural and legitimate use of water by that consumer would bring him under the highest rate. But he says to his neighbor, "See here; you take water from me; I will pay for it, and we will adjust the bill by our

meter rates." And by that means he drops his rate, and his neighbor's as well, down to the next rate. Has he a right to do that? That is what that question means. When he buys water has he a right to sell it at retail to anybody?

MR. GERECKE:—Where it is a question of meter rates or where the water is measured, should there not be then a special contract with the company? I come from Newburgh, where the water is supplied to the city by gravity, and the water taxes based on frontage, heights of houses, and the number of families in them, and then only pay a certain rate by the year. We tried to introduce meters there, but the common council would not let us. A few consumers, breweries and paint works, had to pay a very high rate for their water, and actually the city drove them out of business. They had to move away on account of the high water rates. For elevators and such things they only paid $50 a year; steam engines were rated by the horse-power; they had to pay a certain rate per horse-power, up to five or ten or fifteen. They complained because, for instance, livery stables would let the water run all the time without a stop-cock on the hose. We wanted to put meters on and the council stopped us. I find in the West they are all using meters, and I think where meter rates are introduced on a sliding scale they should be controlled by special contracts.

QUESTION:—"In case of a contract to furnish water for a specified sum per annum, the maximum amount of water permitted to be used being also defined, has the consumer the right to sell or dispose of the unused balance? Can he be restrained from wasting such unconsumed balance?

MR. LARKIN:—That has been answered. We have just discussed that.

MR. DUNHAM:—I wanted to reply to Mr. Denman's statement, and tried to reply to it while the previous question was being discussed; but this question is practically identical with the other. Is it not true where a city has established works a certain relation exists between the citizens and the city, as to the manner of paying for the advantages of the works so established? It is not expressed in the rate book, perhaps, but is it not safe to be inferred that they are to assist each other according to a fixed and somewhat definite rule? And can they accomplish that if one man gets an advantage by taking water through another man's meter, and in that way avoids paying his just proportion of the city tax?

MR. DENMAN:—I see a difference between these two questions. One is where the quantity is not named, and the other is where you agree for a certain sum per year to furnish, we will suppose, a railroad company with a certain quantity of water. If the railroad company does not use the quantity that is stated in the contract, has it a right to dispose of the unused balance? To put it in a little plainer form, perhaps, you agree for one thousand dollars a year to supply a railroad company with 20,000 gallons of water per diem and no provision is made for anything in excess of that. The railroad only uses 15,000 gallons. Has it a right to dispose of or waste the 5,000 gallons per diem that it does not use?

THE PRESIDENT:—We have just a few minutes before the time of our adjournment. I understand Mr. Gerecke has a volunteer matter which is not very lengthy, and perhaps we can hear from him before we adjourn.

MR. GERECKE:—Mr. President, I have only a few remarks to make about a question that I heard mentioned yesterday by our President in his paper in regard to aerated water. I think the method of aerating water is misused. It is all well enough to aerate water to dispose of the bad smell or taste, but the way it is done, by putting air into the pump, is erroneous and wrong. I have been in Chicago now only about two months and a half, and I have found a state of affairs there which shows that thing was carried on too far. We had not *aerated water* there, but we had *wet air* only. The aeration of water was carried on to such an extent that one of our largest engines did not pump one gallon of water in nine years, and which should have supplied 32,000,000 gallons of water a day. It seems incredible, but that is a fact, and you can see that statement in one of the reports which I made and which is printed in the *American Engineer*. It is too lengthy to read here, but the statements are made and proven.

I hear also that in many cities where they are using steam engines for pumping they are using a considerable amount of air for air cushions. The thing is simply this: The valves which they are using in those engines are constructed wrong; double-beat valves must be made in such a way that they open easily and close gradually, and when the plunger comes to the end of the stroke the valves should be closed. We have found great trouble from the fact that the valves present too large an area to the inflow of water, not being heavy enough, they float; if that is remedied you will find that your pump will work without

any admission of air. The air is only needed to supply the air-chamber in the delivery pipe with air, make a cushion for the water going into the delivery pipe, and keep it in motion at the end of each stroke. As soon as you introduce air into the pump-barrel it makes it very unsafe, as there is danger of bursting the pump if the bucket should strike the water on the down stroke. That very thing we had in Chicago when the pumps on the big engine burst. Both pump-barrels are gone. They had to regulate the water in the well down to the lowest possible point to keep the suction-valve from floating, and one day when they had the water too low the pump took air in and burst both barrels. The engine has a seventy-inch steam cylinder and a 54-inch pump now. They were originally 57-inch, but after the accident the pumps were bushed with cylinders an inch and a quarter thick. This was all done on the sly; no report of it was made in the annual reports. The valves in the big pump were wrongly constructed; the weight of the valve itself is so small, only half a pound to the sqare inch, that they will not settle down in water. To settle them, or make them seat, they drove all the water out of the pump by putting an air-cushion in such a quantity that they had a lot of air to spare, and the whole barrel was full of air. You will find that stated in the *American Engineer*. I have the papers here, and I will leave them in the next room for you to read. They contain indicator cards, taken off the engine. All the cards are drawn one over the other, to show how the necessary power of the engine was reduced from about 1350 horse-power to about 600, and you all know that you cannot do 1000 or 1300 horse-power of work by only 600 horse-power. The engine did not do any good at all; they all seemed to be glad that they could pump water as cheaply as they did, but the amount of coal which they used was entirely thrown away, and millions of dollars' worth of damage was done. Where they wanted water they could not get it. You will find another statement in the papers: The pressure in the city pipes was much reduced on one side of the tower, and they could not account for it. It seems really incredible that nobody was there to see that as all these pipes were connected with the stand-pipe, the air which they pumped partly escaped through this stand-pipe. The air showed the same pressure in the pipes as the water did; but after a part of the air had escaped there was only a reduced pressure on the other side of the stand-pipe. The city suffered, not having any water in the higher stories. They could not account

for it. But you all see it now plainly enough. What little water they had in the pipes was spurted out, mixed with air in such a way that they had hardly any use of it. The first morning when I came to the hotel I noticed that the water looked perfectly white, and that it was blown out all over the room by the air pressure behind it.

Then another thing. I found one morning on the street a man going around trying the hydrants to see if they were frozen. He opened the valve, and air was blown out. I tried it again, and so we tried different corners, six times, not a drop of water coming out, only air; and I told him he need not try any more, there was no water in them. And it is actually a fact that the hydrants had no water, nothing but air. We pump in more water now, and I hope in a week or two we will be ready to supply the city with water.

MR. LAKIN:—What did you do with the air pumps on the suction? (Laughter.)

MR. GERECKE:—The air-pumps are stopped now, and I hope we will never use them again. On these new beam engines which they have on the West Side they had two air compressors, one for each pair of engines, and Chief Engineer Mason wanted to either have those air pumps running or something else. He tried to dig a hole for me, and *he* got into it, and he was discharged, and since then the air compressors are stopped.

This idea of pumping air in to make the valve set easily is radically wrong. Fill the pump solid with water, and let the valve close itself, and there is not a bit of danger of doing any harm; but as soon as you pump air in and the plunger strikes the water there is danger of bursting the pump every time. I hear that a good many cities are doing the same thing—using air. Examine the valves and see if they are right; and if the valves are right, there is no need of any air.

MR. DENMAN:—Mr. Chairman, does not that account for the discovery of natural gas in Chicago? (Laughter). We have heard nothing of it since Mr. Gerecke has been there.

MR. GERECKE:—Mr. Hesing came one day to me to the office and said: "Since you told us in your paper that there is only air in the water I told my family to drink as much water as they liked. Before we thought it was sewer gas or bad stuff in the water." The water looked as white as milk when first drawn, but when the air escaped a few

minutes later the water was clear. We have beautiful water provided we take it from the lake and not from the shore inlet. The shore inlet is impure water, and they only use it when the ice is so thick at the crib that it will not let any water in the tunnel.

MR. LAKIN:—I would like to ask Mr. Gerecke just one question, and that he need not answer now unless he wants to. There was supposed to be foul water in the pipes in many places in Chicago. Did you ever investigate to ascertain whether that was due to the air in the water or not.

MR. GERECKE:—No. You know we have had lots of trouble lately. One of the engineers who had been discharged for some cause before I got there knew that there were some connections made to the shore inlet. To let in the hot water from the air pumps to thaw away any ice that might be in there, a connection had also been made with the sewer, which was known only to this one engineer, and wanting to take revenge in some way for being discharged, he showed these connections to a newspaper reporter on Washington's birthday, and the next day there was an article in the *Times* calling attention to the disgrace of the city. As soon as our men discovered it it was remedied. There was quite a commotion in Chicago that such a thing should have happened.

MR. LAKIN:—What I meant by the question was this: Whether this air, being pumped into the mains and being circulated throughout the city, became chemically changed so as to make the water obnoxious?

MR. GERECKE:—No; I doubt that. I do not think the air did any harm.

MR. LAKIN:—From lying idle on a dead end, or anything of that kind.

MR. GERECKE:—No. On the West side we found a very queer state of affairs also. For instance, the evaporation tests for coal was managed in such a way that the contractors got extra pay for high duty coal, and yet they never fulfilled their contract by about 22 per cent. The engineers carried on coal tests which was entirely wrong—for instance, measuring the water and the coal for only two boilers, while four were used to supply the steam, and measuring the water in tanks when it was 180° instead of 50 or 55, with which these tanks were filled when graduated. For instance, they evaporated 11.93 pounds of

water with one pound of coal by using four boilers and measuring for two. When I measured water and weighed coal for four boilers I got 9.1 pounds. Instead of evaporating twelve pounds, as the contract called for, it was only 9.1 pounds. So you see they were also short 22½ per cent. On the North Side it was even so bad that they got the coal bill up from $5.05 to $6.21. In a few months they had $18,000 extra from the city for high duty coal which the city never received.

Adjourned.

AFTERNOON SESSION, WEDNESDAY, April 15th, 1888.

Called to order at 2:30 by President Fanning.

MR. DECKER:—In relation to the matter referred to the Executive Committee this morning in regard to exhibits by non-members, the Executive Committee have decided to recommend the adoption of the following resolution:

Resolved, That all exhibitors at annual meetings of this Association, in order to enjoy the advantages they seek, must be associate members.

I move its adoption.

The motion was seconded and carried.

Mr. H. F. Dunham read the following paper:

ONE PHASE OF THE PROBLEM.

The problem is to supply pure water. The phase presented is from a point of view which is not elevated nor lighted up by much wisdom.

In that excellent work upon *The Water Supply of England and Wales*, by C. R. DeRance, a work that should be widely read in this country, it is pointed out that the early growth of the city of London followed unerringly the deposits of gravel, and it was only after water systems had been established that the neighboring clay formations were built upon. In a country so large as our own and with so many diversified interests, we could hardly expect by statistics of the growth of states and cities to show that our development as a nation resembled that of ancient London as a city, but it will be admitted that the conditions are somewhat similar. The lakes and streams of New England and New York, and that vast system of lakes and rivers upon which so many states border, define an area that may be compared to the gravel districts on account of the readiness with which good water can be obtained. Here and there it may be necessary to exercise a little more caution to go further out from

shore or to see that the shore is not made offensive, but no one doubts that for a long period it will be comparatively easy to supply the large cities of this extensive portion of our country with good and wholesome water. But the districts corresponding to those early defined clay areas, we have them and to a certain extent we avoid them. Other things remaining the same, any of us would prefer the water of the Detroit to that of some of the Southern rivers, and such preference affects the prosperity of the district.

To members of this association, however, there is little need to define or describe those bad water localties which have taxed the ingenuity of engineers, and in which engineers have taxed the ingenuity of water works superintendents to the utmost. You all know where they are and the difficulties they present are increasing in a ratio greatly out of proportion to the increase in population. Only a few years ago the engineer was comparatively alone in his work. Now a whole army of physicians, chemists and microscopists are driving him to the wall with facts and theories that cannot be disputed. Every state board of health report may prove a stumbling block, but it is one which he should welcome and for which he should be grateful. (Our association would be benefitted if closer relations with the different state boards of health could be established). We can no longer find comfort in thinking that after all it may not be so bad, for recent discovery throws backward its light upon the statistics of older communities and shows us there the results of methods like those upon which we now rely. Water, not as rivers furnish it, which in many places is bad enough, but as man has polluted it, is being supplied through pipes as it has been for hundreds of years "for all purposes." (May the honesty of the man who first used that phrase never be questioned). We should not overlook the attempt at purification, and great credit is due to inventors and all those who have helped to awaken interest in the subject. But to purify the water for a great city is a very difficult matter. To suggest nature's method of thorough purification brings you at once to notice the lavish use of time and space by which her success is attained. Cheap practice is not her practice. But all this about abundance and scarcity, about good and bad water, is mere commonplace and unworthy of your attention for an instant, except as it is aimed at a popular error which we may call a national error, for it leads to national and dreadful results. There is no need to remind you that we all look to the people for support and assistance in these important questions of method and expenditure. Their opinion and action are essential to every undertaking.

Now, in this interval of a few years, during which so much has been discovered that calls for prompt and decided effort, the public has been led into a position where such effort becomes difficult. It is true the impression that water is free and not a saleable article has been largely removed, but in its place we have the no less dangerous notion than in all places a certain definite sum of money should pay for a certain quantity of *some kind* of water, and, so far as I know, it will.

Men have buried themselves in statistics and struggled with rooms and height and depth to establish a uniform basis—they have sought for an "average rate" as if it were a lucky number that once known would secure to them the prize of per-

manent happiness, and in thousands of cases they have found it so. Men of liberal education have pointed with conscious pride to the low rates in their cities when those rates should have been looked upon as a disgrace. Councilmen and others with the interest of the people at heart have assumed in establishing rates that unless the rate was as low as in some neighboring city—where the conditions were entirely different—people would be driven away from their town or not be attracted to it, and to-day such notions are common.

They are all wrong. We might as well stop the transportation of grain, and then, by means of adulteration, make the price of flour uniform all over the country; the same in New York and Minnesota. You might as well say that because foundations for buildings in Detroit cost, upon the average, only five dollars per square yard we can pay no more than that in our city, regardless of what the excavation shows. If all the cities had adopted that course, the architecture of the country could hardly have been in worse condition than the drinking water of the country is now, when compared with what it ought to be. Severity of expression may be excused when people are thoughtless, or when they do wrong under the impression they are doing right, and we do not want in any of our valleys such "crucial experiments upon half a million people", as we know to have been performed in the valley of the Thames. Wholesome water should be made the one and only basis, and the rate charged should be determined by the cost of procuring it, and there is no city in our country, where people cannot afford to pay that rate better than they can afford any rate for unwholesome water.

I would not give you the impression that my faith in the intelligence and good intentions of the people is weak; on the contrary it is strong. I would be quick to recognize that modern tendency toward a safe and comfortable life, which is swelling like a tide and carries us all toward that point where we cannot look to any other people for example.

Where the issue is plain and in no way obscure there is less to criticise. We have an illustration in our midst: Six thousand families in Cleveland are using well water where wholesome water is convenient. But how was it found out that there are six thousand? Why is the fact published and known all over the county and wherever English or German papers are read? Why are steps being taken to make that number less? It is simply because the intelligence of the present is demanding that after the best has been provided it shall be accepted, in order to prevent suffering. To demand that the best possible shall be provided for the same purpose is no less a duty.

MR. DUNHAM:—Mr. President. I would like to say that when you first asked me to prepare a paper for this meeting and I declined to do it, as you will remember, I was entirely in good faith, and after that, as you may recall from your correspondence, I begged the invitation to present a paper, stating in the letter that a subject which was quite new to me, and about which I knew very little, had come up in a way that it seemed to me might merit some attention, and for that reason I would, after all, like

to present a paper. It was my notion to present a more extensive paper upon the subject which I have indicated here.

Some three or four months ago, in connection with work in a large town, my attention was called to the advantage that would arise from dividing the supply—that is, from duplicating, so far as it would be necessary to do so, the pipe system, using pipes of a proper size for the distribution of water for drinking, cooking and like purposes, for which very pure, good water should be used. The water for such a supply, I had thought, might be obtained in many cases from artesian wells, in other cases, possibly from the surface, where a great care would be taken to make that water pure and wholesome, and keep it entirely free from contamination. With a demand of two or three gallons per individual, or a total demand in a city of half a million people of no more than one million gallons per day, it seemed to me that an amount of attention and an amount of money sufficient to accomplish the thorough preparation of that water might be attempted.

Then the question of how cheaply that water could be delivered to the people in that city came up, and it was my purpose to bring here a paper in which that would be taken up and discussed, but I did not have the time to carry it out fully, and failed to do it. In thinking of it later, it occurred to me that where artesian water could not be obtained, it would be possible, with fuel at the price it is in this country, to distil the water required for a large city—that portion of water, I mean, that is required for such purposes as I have indicated, and I would have liked very much to present to you to-day a paper in which that phase of the question should have been pretty thoroughly commented upon or presented. I have found out a little in regard to the cost, but not enough to embody it definitely in a paper. With soft coal at from one to two dollars per ton, a quantity of water sufficient for family use, and of the quality which I have indicated, ought, I think to be delivered to families for less than they pay now for their domestic supply. That would at first sight seem exhorbitant, but I believe it may be called an unquestioned fact that if such a supply was introduced into a city where the water is now unfit for drinking, it would be a good investment on the part of every consumer to pay the required sum. In places where a large amount of money must be expended to make changes to filter, to take water from places that are better than those from which water is now being taken, there would be quite a large margin

that could be used for the purpose I have indicated. The apparatus would be comparatively simple. There should be, of course, proper facilities for evaporating, for thoroughly aerating, and for delivering under pressure through pipes in the way that I have ineicated, and the same as we do now with our larger quantities.

I simply throw this down as a suggestion—as something that I believe to be worthy of consideration—and whilst we may not be able to point to the place immediately that will be encouraging for a company to set up such a plant, I think it reasonable to believe that within a short time the occasion may arise when such a plant as that would not be only desirable to the city, but a substantial basis of investment for capital.

THE PRESIDENT:—Mr. Dunham offers a suggestion that is worthy of consideration. It calls to mind the fact that there are a number of cities that have a water supply which is not considered the very best for drinking water, cities in which there are companies for supplying water from springs, carrying it about and supplying it to families. Possibly those would be places where Mr. Dunham's suggestions might be followed out. In many cities spring water is supplied entirely independent of the public water supply.

MR. OLIPHANT:—Mr. President, I was going to make a remark here about distilling water. I have had a great deal of experience with distilled water. Now, we are frequently asked the question whether distilled water is pure and wholesome for drinking purposes. For cooking, we will say that it is, but for drinking purposes is it pure and wholesome? I would like to get the mind of the engineers here. I have had a good deal of experience with it, and I have seen a great deal of sickness through it, which I will be able to prove, if any proof is wanted.

THE PRESIDENT:—Does anyone wish to remark further on that? I think if it was determined that it was not pure, it would be a very easy matter to add the proper amount of mineral ingredient that might be lacking.

MR. DUNHAM:—I would like to ask as to medicines. I think they are usually put up in distilled water. It may not be on account of health that it is done, however. I might say further in regard to the softness of water. I believe the Rivers Pollution Commission of England have decided that, so far as their observation extends, (and they have made quite a study of it), they have no reason

for believing that soft water is more unwholesome than hard water. And further, in New York there is at the present time quite a large concern distilling and preparing, I suppose thoroughly aerating, and perhaps charging slightly with carbonic acid gas, water for use in the City of New York. It is taken in bottles and distributed at different points in the city; the same as beer is in this city.

THE PRESIDENT:—That is the practical result in some places, where spring water is being sold independent of the public water supply.

MR. RICHARDS:—Could the water company justly go into peddling the water in bottles?

THE PRESIDENT:—That plan is carried out in quite a number of our towns and cities where the public supply is not satisfactory. It is carried about and the domestic tanks filled, together with ice, during the summer. Quite a business has grown up in a number of our cities in that way.

MR. DUNHAM:—There is no practical question about carrying it out, about the piping of a city again, and having more fixtures. We do that frequently, with every increase in the number of gas companies and with every steam-heating plant that comes into a town. Putting it upon its practical basis, whenever the time comes that men are as willing to invest money to insure to their families water that can as truthfully be called pure as the beverage that they require for themselves, there will be no question about the carrying out of any such plan as that.

MR. GARDNER:—Mr. President, taking hold of the conversational tone of this argument, I would like to ask what cities of the United States have a duplicate line of mains, that is, one for household purposes and the other for public supply or the rougher purposes of consumption?

THE PRESIDENT:—I do not know of any myself now.

MR. DIVEN:—I think that to some extent Rochester has that duplicate system.

THE PRESIDENT:—That is for fire purposes, I think, independent of the domestic supply.

MR. GARDNER:—Mr. President, are there any cities in the world that have this duplicate system?

THE PRESIDENT:—I do not recall any.

MR. GARDNER:—Montreal, I am told, has that duplicate system, and I believe St. Petersburg has it.

THE PRESIDENT:—It is my impression that Montreal has not. I supposed their water all came from the Lachine Canal works. They have a very extensive pumping plant there, partly by turbine and partly by steam power, and I supposed the water for domestic uses was distributed from that generally, although there may possibly be some small water companies that supply water from springs. That has happened in many of the old New England cities, where the old private water companies had their lead pipes running about the cities before the public water supply was established. I know in one case where I was putting in public works there were five water companies, each having its lead pipes going through the town. Some of them had wooden pipes also. We came in contact with their pipes as the public supply pipes were being put down. That was the case in many of the old New England towns, where they had brought in spring water and distributed it by lead pipes to perhaps thirty, forty, or hundred different families.

MR. GARDNER:—But nothing like a deliberate double system, so far as you know?

THE PRESIDENT:—Not as a municipal system. I did not recall anything of that kind.

Mr. F. L. Fuller presented the following paper on "The Indirect Income of Water Supplies:"

THE INDIRECT INCOME OF WATER SUPPLIES.

That this is an age of progress all will readily admit, neither will any deny that improvements in the conveniences of living have been numerous and of great value. Anything that reduces the amount of drudgery required of any part of a community is a real gain. Laziness does not enter very largely into the make-up of the American people, and all the time saved from hard labor will be used to good advantage.

Our lives have, and always will have, enough of toil in them, to make it wise to encourage labor-saving devices. The strength once expended in hard, but necessary labor can now, in part at least, thanks to man's ingenuity, be turned to higher ends. Machinery has come to our aid, and every year, men of practical wisdom are adding to the number of appliances for lessening labor and increasing human comfort. It is unnecessary to take the time to call them to your notice. If you will allow your imagination to go back fifty years and contrast that time with the present, you will be aware of the changes which have been wrought. And among them all is there one more beneficent

than the modern Water Supply? What town or city that has once enjoyed its benefits, could be induced to part with it, although the struggle to secure it may have been long and severe?

In the case of our large cities, where the water is used for domestic purposes, fire protection, generating steam, flushing sewers, watering streets, &c., the giving up of the water supply would be most disastrous and imperil its very existence. The sentiment in favor of a public water supply is so rapidly increasing that towns of small population and limited resources are fast availing themselves of its advantages.

When the question of a public water supply is agitated, one of the first questions asked is, how much will it cost? and what income may be expected from it? In our calculations as to whether it will pay, we are perhaps too apt to forget that water accounts can be made up of anything but the dollars and cents received as water rates, or paid out for construction or maintenance. I hope to show that the indirect income which a town or city derives from its system of water works, which does not show on its books, because it cannot be represented by a money equivalent, is no small item.

1st. By promoting health.

The fact is fully established that pure water is not only essential, but indispensable to health.

If the germ theory of disease is true, if disease is due to the presence, in our bodies, of certain harmful species of bacteria which are easily propagated and transported in water, then we have a nother and strong argument for unpolluted and uncontaminated water: That the average water supply is better than the water from the average well, is no doubt a fact.

At the last meeting of the New England Water Works Association, the statement was made that Typhoid fever has practically become a country disease. The following table, copied from the Massachusetts Registration Reports for 1886, with editorial remarks by Dr. S. W. Abbott, Secretary of the Mass. State Board of Health, is a good proof of this:

DEATH RATES PER 10.000 FROM TYPHOID FEVERS IN CENSUS YEARS 1865, 1870, 1875, 1880 AND 1885, BY COUNTIES.

Counties	1865	1870	1875	1880	1885	Average.	Population 1885.
The State	13.4	9.1	6.4	4 9	3 9	7.5	1942141
Barnstable	16 7	12.8	5.6	4.1	2.7	8.4	29845
Berkshire	23 3	8.2	7.6	5.6	3.3	9.6	73828
Bristol	14.5	7.9	5 4	5.4	3.8	7.4	158498
Dukes and Nantucket	17.8	22.7	12.4	3.7	6.9	12.7	7277
Essex	12.9	9.4	5 1	5.6	3.8	7.3	263727
Franklin	25.2	11.6	8.9	4 9	3.7	10.9	37449
Hampden	16.1	15.4	9.7	7.2	5.1	10.7	116764
Hampshire	18.3	10.3	10.9	5.5	4.9	10.0	48472
Middlesex	8.9	6.5	5.1	4.0	3.5	5.6	357311
Norfolk	8.9	5.9	5.9	3.4	4.4	5.7	102142
Plymouth	20.2	7.8	6.0	5.1	2.9	8.4	81680
Suffolk	7.7	7.6	6.6	4.1	3.7	5.9	421109
Worcester	17.7	12.1	6 6	6.0	4.2	9.3	244039

Dr. Abbott remarks in connection with this table: "It appears that in all the counties there has been a steady diminution in the mortality, from this disease. The uniformity of such decrease is especially noticeable in the most populous counties". The lowest average mortality occurs in the counties made up of large towns and cities, most of which have systems of water supply and sewerage; the highest average appears in those counties composed of small, sparsely settled towns, having no public water supply or drainage. In the supplement to the First Annual Report of the Massachusetts Board of Health, Lunacy and Charity, Dr. Abbott says, in speaking of local boards of health, "The very fact of the greater frequency of typhoid fever in country districts than in the cities, on account of the absence of a general water supply and of adequate sewerage, proves the necessity of the existence of such boards and of their constant supervision of the location of wells and the proper construction and location of sewers and vaults." The same author, in the same report, makes this statement: "The early introduction of a pure water supply with adequate sewerage, in all large towns in the State, is a matter of prime importance. If the completion of such works should be attended with results similar to those witnessed in many cities of England and Wales, we should be enabled to record a decided diminution in the mortality, from typhoid fever, within the following ten years, and a consequent gain to the State, which could scarcely be reckoned in terms of pecuniary value".

Without a water supply we can have no sewerage systems as now generally operated. The water carriage system is a success, so far at least as removing waste and refuse from our houses is concerned. The general health of people in a well sewered city or town, having a good water supply is better, as has been shown above in regard to one phase of disease, than that of the corresponding class in the country. Of course the health of these cities and towns must be vastly better than it would be, if they should give up their sewers and aqueduct water, and go back to leaky vaults and cesspools, and fouled and polluted wells.

The "Ninth Report of the Medical Officer to the (English) Privy Council" for the year 1866, is most interesting and valuable. From it is taken the following table, which shows the improvement in the public health in twenty-four cities and towns, due to works of dralnage and water supply:

Table Illustrating the Improvement of Public Health resulting from Works of Drainage and Water Supply

Population in 1861.	TOWNS IN ORDER OF THEIR POPULATION.	Periods for which the Death rates are compared.		DEATH RATES PER ANNUM, TOTAL AND PARTICULAR, PER 10,000 OF GENERAL POPULATION FOR EACH OF THE COMPARED PERIODS.													
				A. General Death Rates.		B. General Death rates after excluding Small Pox and other infantine epidemics.		C. Typhoid Fever.		D. Diarrhoea, excluding Cholera so called.		E. Cholera in each of the three Epidemics.			F. Phthisis.		
		Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	1848	1854	1866	Before the Works.	After the Works.	
160,714	Bristol	1847-51	1862-65	24½	24 2	21 5	20 5¾	10	6½	10½	3½	82	11	1½	31	25½	
63,056	Leicester	1845-51	1862-64	26 4	25 2	23 6½	22 5⅓	14 3-5	7¾	16	13⅓	1	10	....	43⅓	29¼	
52,778	Merthyr	1845-55	1862-65	33 2	26 2	29 2½	22 1¼	21⅓	8⅔	11⅓	6¼	267	84	20	38⅔	31⅓	
39,693	Cheltenham	1845-57	1860-65	19 4	18 5	18 2	17 2	8	4⅓	8⅓	7	.....	.....	....	28¾	21⅓	
32,954	Cardiff	1847-54	1859-66	33 2	22 6	29 4	19 1½	17½	10½	17¼	4½	208	66	15½	34¼	28⅔	
30,229	Croydon	1845-50	1857-64	23 7	19 0	20 7	17 8¼	15	5½	10	7	27	21	2	.....	.....	
29,417	Carlisle	1845-53	1858-64	28 4	26 1	24 4	22 5	10	9¾	11⅓	12½	22	6	....	32	35 2-5	
27,475	Macclesfield	1845-52	1857-64	29 8	23 7	26 3⅓	21 7½	14¼	8½	11¼	11	9	1	....	51½	35 3-5	
24,756	Newport	1845-49	1860-65	31 8	21 6½	27 5	18 7½	16⅓	10⅓	11	6½	112	1½	12	37	25	
23,108	Dover	1843-55	1857-65	22 5½	20 9	20 3	18 7	14	9	9½	7	40	10	4⅔	26¼	21¼	
10,570	Warwick	1845-55	1859-64	22 7	21 0	20 9¼	19 1¼	19	9	5¾	8	10½	.....	....	40	32⅓	
10 238	Banbury	1845-53	1857-64	23 4	20 5	21 4	18 4½	16	8½	11⅓	5½	2	1½	....	26⅔	15⅔	
9,414	Penzance	1843-50	1856-65	22 1	22 2	19 7½	20 0⅓	7½	8	5⅓	9⅓	.....	.....	....	30⅔	29	
9,030	Salisbury	1844-52	1857-64	27 5	21 9	25 3⅔	19 8½	7½	1¾	6⅓	2⅓	180	14¼	....	44⅓	22⅔	
8,664	Chelmsford	1843-52	1855-65	19 6⅕	21 5	18 0	18 7⅓	12	12⅔	7	8	4	.....	....	32⅓	42⅔	
7,847	Ely	1845-52	1859-64	22 8	20 5½	21 0	18 6½	10 2-5	2½	3¾	4¼	.....	22	....	31	16¾	
7,818	Rugby	1845-51	1855-63	19 1	18 6	16 4	16 4½	10	9	2 1-5	7½	.....	.....	....	28½	16¼	
7,189	Penrith	1845-52	1856-64	25 3½	25 0	23 5½	23 0½	10	4¾	3 5-6	4 5-6	9½	2½	....	39⅓	37½	
6,823	Stratford	1845-53	1860-64	21 7	20 2	21 2¼	17 8	12½	4	11¼	5¾	.....	.....	....	26⅔	26½	
6,494	Alnwick	1845-51	1856-64	26 2	24 7	24 0	22 1½	13½	8⅔	7	4⅔	205	.....	....	28⅓	35	
6,334	Byrnmawr	1843-52	1856-65	27 3½	25 2⅓	23 2	20 9	23½	10¼	5	4¾	100	.....	....	28⅓	30	
5,805	Worthing	1843-52	1857-65	15 5	15 3	13 9	13 6½	7½	9¼	4¾	5½	.....	.....	....	30½	19½	
4,490	Morpeth	1845-52	1856-64	26 2	24 7	23 4	22 5	16½	10	8½	14½	14	11½	....	30½	28	
3,840	Ashby	1845-51	1855-64	21 6	20 2½	21 3	18 4	13⅓	5¾	4	8⅓	.....	.....	....	25½	31⅓	

In nine of the above cities and towns there was a reduction in Typhoid Fever of one-half. In ten the reduction was between one half and one-third. In two it was slight. In three there was more or less increase.

The writer is not aware that similar information, in so complete a form, exists, regarding American cities and towns. It is hardly possible that a comparison similar to that in the table referred to, could be made of our own cities and towns in the future, or even at the present, because towns now provide themselves with systems of water supply and often of drainage, before they are of the size of some of the smaller of those in the list given.

Mr. John Simon, the medical officer making the report referred to, and one of the best of English authorities, says:— "Typhoid fever and much endemic diarrhœa are, as I have often reported, incessant witnesses to the same deleterious influence, (lack of water supply and drainage), typhoid fever which annually kills some 15,000 to 20,000 of our population, and diarrhœa which kills many thousands besides. The mere quantity of this wasted life is something horrible to contemplate, and the mode in which the waste is caused is surely nothing less than shameful. It is to be hoped that, as the education of the country advances, this sort of thing will come to an end; that so much preventable death will not always be accepted as a fate; that, for a population to be thus poisoned by its own excrement, will some day be deemed ignominious and intolerable."

Sickness and death are expensive and wasteful. Health and strength are elements of power and add to a man's usefulness, and to the country's wealth; and if a water supply has anything to do with them, it should have its due share of credit. The sprinkling of streets in summer, is a luxury, conducive to the health and comfort of the people and the preservation of our roads. The decrease in the cost of repairs on gravel and macadamized streets, will go far towards paying the cost of sprinkling, to say nothing of the comfort of passing over them. In our smaller cities and towns, a well kept lawn is a continual source of pleasure, and nothing is more essential to its condition than a proper supply of water in the dry months of summer.

2nd. By saving property.

This is closely allied to the question of insurance to be spoken of later.

We cannot doubt, in view of its perfect adaptability for the purpose, and its wide spread distribution, that one of the objects for which water was made, is to protect us from the destructive action of fire.

Fire and water are two of the most effective agents which man has at his disposal; but unless kept within proper bounds they may become his greatest enemies. Much of the material with which we are surrounded is inflammable, and if by any chance this takes fire, the safety of life and property demands that water be at hand, so as to be applied instantly and in sufficient quantity.

This can be best done in connection with the domestic supply, by water under pressure, due either to the force of machinery, or its own weight. The object of the modern water supply, is to provide water for domestic uses under such pressure, as to be available at the shortest possible time for use in large quantities, if necessary, upon an out-breaking fire.

The building in which the fire originates may be destroyed or practically ruined by water, but the fire will probably be con-

fined to this one building, and herein lies the value of the protection of which we are speaking.

The power to prevent a wide spread conflagration lies, in most cases, in a properly arranged system of Water Supply.

In planning a Water Works system, care should be taken not to locate the hydrants too near large wooden buildings, because in case of fire the heat might render it impossible for the firemen to use them. This, I understand, was one reason for the great destruction by the recent fire at Amesbury, Mass.

Whenever property is destroyed by fire, whether it be insured or not, there is a positive loss to some one; so much actual value wiped out. Some person or persons will be so much the poorer, by the value of the property destroyed. The relief from anxiety and apprehension is a matter of no small moment, and may well be included in the indirect income which we are considering.

3rd. By reducing insurance.

Fire insurance is virtually an arrangement by which losses by fire are divided among a large number of persons. If my property is destroyed, and you are insured in the same company, you contribute the insurance rates you have paid towards my loss. If all property, or if no property, were to be destroyed, there would be no advantage in insurance, except to the companies. If no property could be burned, insurance rates would be a useless expenditure. If all property were sure of being burned, the money paid out in rates and premiums would exceed the amount of damage to be received when the property was destryed, because the company must receive some compensation for carrying on the business. In the former case, rates would be very low, only sufficient to cover the cost of doing the business, say, a small fraction of a per cent. In the latter case they would be very high, one hundred per cent. of the valuation, plus a somewhat larger amount than that mentioned for transacting the business, which, in this case, would be more laborious than in the former, owing to a constant settlement of losses, rewriting of policies, &c. I am assuming that under the two conditions we are considering, people would still continue to insure.

Property is actually under neither of the conditions mentioned. Some of it will, some of it will not be burned. It is just this uncertainty, which gives insurance any value, and the less the uncertainty or the greater the certainty or probability that it will not be burned, the less the cost of insurance becomes, because the property is more nearly under the first of the conditions mentioned.

A gentleman, Mr. Geo. P. Field, of Messrs. Scull & Bradley, Boston, well informed in matters of fire insurance, makes the following suggestions: "One thing that people should consider, is the saving effected in the reduction of the amounts of insurance carried, which is an item that insurance companies cannot figure. We always find that the introduction of water into a place, improving the fire extinguishing facilities, results in a decrease in the amounts of insurance carried, particularly on the more hazardous risks." "The Insurance Companies in New England are always ready to recognize the introduction of water by a very substantial reduction in rates."

From information kindly furnished by other gentlemen connected with insurance organizations, I conclude that there is generally a reduction of from 20 to 50 per cent. on rates where water is introduced. The amount of the reduction will vary according to the character of buildings and their location, completeness of the water works system, efficiency of the fire department, &c.

4th. By encouraging manufacturers.

Competition is now so great, in the manufacture of all standard goods, that men of prudence will not invest their money unless they feel that it will be reasonably secure. The question of insurance is an important one. There are now insurance companies making a speciality of insuring manufacturing property. They require of mill owners the best appliances for preventing and extinguishing fires, which a long and careful study of the subject has suggested. By thus reducing the number of fires and consequently the loss, to a minimum, low rates of insurance are secured.

The question whether a large manufactory, with its power to change raw material into finished products and employ large numbers of dependent workmen, shall be built in one town or city or another, or whether it shall be built at all, is often largely determined by insurance rates.

The efficiency of stand pipes, hose and automatic sprinklers require that they should be supplied from some adequate source.

Tanks in the upper stories of mills are of some value, but if large, their weight when filled with water becomes enormous, and if small, their supply is soon exhausted. It may be urged that most mills and factories have fire pumps, operated by steam or water power, which can at once be put in use to extinguish fire, while this is often true, it is also often the case that these appliances are out of order, that access to them may be cut off before they can be started, or they may be disabled by falling walls or other accident. Some independent supply is needed in addition to whatever may be provided, within the mill premises.

Another advantage derived by manufacturers from an abundant supply of pure water is its use for steam boilers, in making certain classes of fine goods, such for instance as white paper and in bleaching and dyeing.

Our streams are becoming so fouled and polluted with refuse of all kinds, that in many cases the water is unfit for anything but power. Attempts to prevent this are being made and will continue to be, but the temptation for towns and manufacturers to get rid of their filth and waste in the easiest and quickest manner, which is generally to turn it into the nearest stream, is so great that it makes the matter a serious one to carry out.

THE PRESIDENT:—Mr. Fuller has introduced some questions that are quite worthy of study. I remember a point in connection with works built some years since. I took occasion to study up the reports of the fire losses for a series of five years before the works were completed, and then for five years afterwards and made a comparison. I found that—supposing the rate before the construction

of the works to be a fair rate of fire losses per annum—the saving in the next five years was more than the entire cost of the works during that time; so that would be one of the indirect incomes of water suppliers. It is a matter worth considering by any city of eight or ten thousand inhabitants, if there are such that have not water supplies. I think that if this matter could be followed out the real value of the indirect income is greater than that shown upon the books of the company as a rule.

MR. DUNHAM:—Mr. President, why is that called an "indirect income?"

THE PRESIDENT:—Possibly to distinguish it from that which appears on the books; it is to distinguish it from the apparent financial income. I should judge that would be Mr. Fuller's idea; if not we would like to have Mr. Fuller explain.

MR FULLER:—I do not know whether the term "indirect" is strictly proper. It is something which is not apparent; perhaps it might be called "the *unapparent* income," if such a word might be used.

Mr. B. F. Stephens read the following paper:

STAND-PIPES FOR WATER WORKS.

Mr. President and Members of the American Water Works Ass'n:

GENTLEMEN:—I once handed my gardener some seed potatoes to plant in drills. He replied: "I never sowed potatoes in drills." "We learn all these things by practical experience." Later, while engaging a coachman, the gardener's "*experience*" presented itself, as I asked him, "Ever had a runaway?" "No sir," said he. "Then I don't want you," said I. And when our honored President assigned me the subject of "*Stand-Pipes for Water Works*," it appeared as though gardener and coachman had informed him that I had had some little experience and a first-class runaway

But, gentlemen, realize if you can the prospective feelings of the writer after reading the first reply to one of 280 letters written to Superintendents and Secretaries on this subject: "I shall be most happy to give you the information asked for, but I really do not understand what is meant by stand-pipe."

I study not to halt in stupid admiration over success, but to be diligent and patient in the investigation of failure.

A stand-pipe, may I be forgiven, I will liken to a bell in the bellfry—a suicide. Its tolling is its life's blood fast ebbing away.

In metals oft-repeated hammering and vibration causes crystalization and impairment of its original tensile strength.

It is estimated that the life of an iron bridge is from 12 to 25 years. The Ashtabula bridge was 13 years old when it fell beneath the weight of 2 engines and one heavy express train.

It is claimed that homogeneous steel is subject to rapid oxidation and unless made fibrous is inferior to iron. The makers of steel now claim that there is a silicious coating over each fiber that protects it from the action of fire, where pure iron would perish. But, be this as it may, Schoenberger & Co., Pittsburg, Pa., on finishing their steel plant allowed their puddling furnaces to stand idle for two years, but now these furnaces are in operation both day and night. At another mill where nothing but steel was used in the manufacture of car axles, hammered muck-iron has been substituted. A master mechanic of a leading railroad says: "His company is throwing out steel and putting iron axles on all new cars." At two mills, where the sole products are railroad supplies. 14 new puddling furnaces have been erected. The manufacture of structural steel is being discarded at a leading mill because mechanics report that steel nuts and bolts are brittle and break easily.

Crystalization of iron or steel in a stand-pipe may be caused by the perpetual vibration and silent hammer-blows of moving water which, slowly but surely by repeated impact turns the fiber into a mass of crystal abiding only for a certain time when some unusual pressure will cause it suddenly to break apart. Add to this the never-ceasing oscillation and concussion, the inaccessibility and inconvenience allowed for inspection and repairs, and one trembles in the attempt figuratively to measure the powerful strain of jar and wear and tear, or to realize the peculiar perils attendant in the preservation and life of a stand-pipe. In view of this the attempt to furnish a paper on stand-pipe must be considered a bold one requiring "Nerve."

In the United States there are as far as known 282 stand-pipes and tanks used for water works. A stand-pipe elevated on a hill, or trestle, or tower, may store more water and perhaps be a more economical plant, where high service is the rule, if always kept filled; but if the object be to satisfy domestic purposes at a reduced head and at the same time conditioned so as to promptly respond for fire pressure then, I take it, the tall stand-pipe of small diameter is the most economical and effective. To serve a town of 10,000 and upwards there is economy in the long run to run continuously with an open stand-pipe of water to cushion against, rather than the direct pressure system.

Some may say, "the lower half of a stand-pipe is of little practical value." It is a very economical ballast.

The stability of high stand-pipes, either with or without guys, introduces the subject of "resistance of wind-pressure." It is quite practicable to build a water tower 250 or 350 feet high, but one's theories, however good, should as far as possible be put to practical tests. Engineers regarded as authorities, and who have given stand-pipes much study, have decided views and some directly opposite. I am on the theory that they are self supporting and maintain their position by their own inherent strength.

A FEW PRACTICAL SUGGESTIONS.

Where it is possible a stand-pipe should be near the pumps to prevent uneven pressure, pulsation and water ram. Their

office is to take up the excess of water and compensate for the deficiency of delivery.

Bottoms.—In structural stand-pipe work I do not favor cast iron bottoms, or steel bottoms, or steel angle iron, or steel rivets.

Brackets.—Wrought iron bottoms with brackets riveted to the outside lower courses reaching up to the second or third sheet should form the base. Brackets may be bolted to and through foundation. Brackets give larger base area and are additional security against wind pressure. The bottom and first course should be made up with a ring of angle iron.

Plate.—The best width of plate is what will practically build five feet. Thickness of iron and length of plate should vary according to height and diameter, always keeping the prospective *future* in view of the probable need of addition to height.

Holes.—Holes should be drilled and not punched. They should coincide or be absolutely true to each other so as to avoid the use of a drift pin. Where three plates join, the overlap must be searfed down while hot so the plates will have a perfect and equal strain at all points. No fulling tool or fooling tool should be allowed at such places.

Manhole.—The manhole should be of wrought iron with wrought flanges and plate, and its position most convenient at the side. (The cast iron manhole is always placed on the sheltered side, and must be covered or protected in winter with box or barrel filled with saw-dust or some non-conductor.)

In-flow Pipe.—The in-flow and out-flow pipe should be the one pipe where the demands will allow.

Overflow Pipe.—The interior of the upper part of a stand-pipe should be kept free and clear. *Inside* overflow pipes, ladders and braces are obstructions. Ice is their enemy.

Anchors.—Anchors and guys are unnecessary. As unpleasant, unsightly and useless as so much barbed wire in the field.

Material.—A stand-pipe should not be built on the economic plan. A careful examination of the Table herewith appended will convince the thoughtful. Let the material be first-class homogeneous-iron, with a generous distribution of angle-iron correctly applied, and it will be found sufficiently strong to anchor itself whether empty or full, as well as to admit of aerial expansion and defy cyclone, tornado or wind-storm.

Height.—To-day several would gladly add to the height of the stand-pipe, but cannot owing to a low factor of safety. The only alternative is to raise and add to the bottom.

Cover.—A *cover* of galvanized iron, conical in shape, is unobjectionable, provided there is provision for a circulation of air underneath.

Freezing.—We know of wooden tanks exposed to 50° below 0, air-space above and below, made tight by grouting the floors, prevents freezing. Injected steam or heated pipe coil, or any application of heat underneath or felted exterior is needless. Frequent pumping at intervals of 8 to 10 hours into the stand-pipe, and letting out or changing the water on coldest days, is the sure, easy and economical preventive against freezing.

Felt Covering.—I had an experience with a stand-pipe 102x20 ft. A felt covering man, a come-when-you-are-away young man, in my absence, induced the executive committee to cover 8 feet of the lower part, guaranteeing his felt covering would prevent freezing. They generously charged ½ the bill to me, which I paid under protest.

Paint.—An asphaltum paint is best. A preparation applied to the Painesville stand-pipe in 1882, stands to-day good as new. It does not crack in winter nor run in summer. Color, steel blue.

Manhole.—The man-hole in the side, on the first course of plate, is generally provided for cleaning out purposes.

Sediment.—*Many* suppose that apparently brilliant and crystal clear water is without sediment, while others know that water pumped into a reservoir will precipitate more or less the particles held in suspension The writer has discovered sediment a foot thick and more deposited from purest looking water, being the accumulation of about a year. Its color was most black and foul. Oh! how much we keep secret in this life. What! one foot of sediment! Hush, quiet! Work rapid for the water is off the town. The *fear* is a consumer discovering it and telling his neighbor.

Color.—Oh! I could amuse you quoting answers to questions under this head:

Louisville, Ky., answered that their sediment was "from a pale and melancholy-yellow to a rich sunset-red."

A large manufacturer of stand-pipes writes: "Stand-pipes are not cleaned out as often as they should be. The method is to empty the pipe; waste the water; take off the manhole, syphon out the water below the manhole plate and send men inside with shovels and scrubbing brushes to remove sediment and muddy bottom-water by hand, then rinse out, apply the 'hole-cover and fill her up again."

This operation costs loss of water, time, a new gasket, extra labor and great inconvenience oftentimes to manufacturers and business interests. Where direct pumping comes to the rescue during this interim extra coal and skilled attendance is required and also what is equally costly, though unexpressed in dollars and cents, is the anxiety or fear of accident anywhere while the stand-pipe is dismantled and *the uncertainty of making the joint water-tight at the manhole-plate*, and the possibility of damage from oscillation or overthrow by wind storm where the stand-pipe is not ballasted with water.

In 1883 the stand-pipe at Painesville, O., had a patented device applied, at a cost of $100, which operates successfully to cleanse it at pleasure *while the pipe is full of water.* After five years use I confidently recommend its utility and adaption as an effective, essential, sanitary adjunct for any stand-pipe. An illustration and detail of description is here given.

Patent.—It consists simply of a sediment discharge pipe passing in through the side and terminating at or near the center and bottom, or where the dish is greatest, of the stand pipe. When the valve in the sediment pipe is open the column of water exerts the pressure and causes a rush of water through the discharge pipe with such force as to carry all the sedimentary

matter and impurities away with it and the reservoir is cleaned in from five to ten minutes. Typhoid fever germs generate in sluggish bottoms.

DESTRUCTION OF STAND-PIPES.

The Lexington, Mo., stand-pipe collapsed June 22, 1885. Its situation was on highest elevation. On a foundation there were raised six cast iron columns 40 inches in diameter by 50 feet in height. Upon these rested the stand pipe 152 feet high by 22 feet diameter made of half inch iron ; capacity 365,000 gallons. When full of water it *burst*, scattering the material as if exploded. The city had been supplied for some weeks but had not yet accepted it.

Victoria, Texas, partial collapse. Size 100 ft. by 16 ft. 70 feet $\frac{1}{2}$ in. iron; remaining 30 feet $\frac{3}{16}$. When 70 feet of water was in the pipe a cyclone or tornado wind of abont 80 miles per hour caused an oscillation, a swaying, then a buckling and collapse of the 30 feet not filled with water. Herewith is an illustration.

Gravesend, N. Y., Oct. 7th, 1886, burst. A total wreck.

Newport, Arkansas. Wooden tank ; burst, great damage resulting.

Caldwell, Kansas, 1887 ; collapsed while building. 150 ft. by 12 ft. 6 ins. The pipe was empty. It doubled over about midway, taking part of foundation like the uprooting of a tree.

Plattsmouth, Nebraska, March, 1887. Partially collapsed by storm while empty.

Cincinnati, O. Burst, a total wreck. Steel too light.

Belleville, New Jersey. 100 ft. x 6 ft. x $\frac{1}{2}$ in. thick.

Franklin, Mass. Iron tank 30 ft. high by 35 ft. diam., contents 216,000 gallons, burst at 3 a. m. Oct. 27, 1887. They undertook to raise it in the air 40 feet and rest it on brick piers. The piers were green and they failed under the weight. The iron was badly torn. A total ruin.

Seneca Falls, N. Y., burst Oct. 27, 1887 ; size 120 ft. x 30 ft. A $\frac{3}{4}$ thick plate fractured. The cause was bad quality of the plate.

Thomasville, Georgia, collapsed on Dec. 10th, 1887, before completion. In the erection of the tower, scaffolding had been built so as to serve as a brace between the centre pier and outer walls. This pier was solid brick masonry of 6 feet diameter. The hoisting of brick to top of tower swayed the pier out of plumb and caused its overthrow.

Houston, Texas, foundation settled. Made of brick and cement. A circular wall with cross sections was too slim a foundation to support a pipe of water 74 ft. x 20 feet.

Kankakee, Ill., collapsed, then blew over, breaking and taking the hold down bolts. Material, steel, 120 ft. x 20 ft.

The Gravesend Stand-Pipe must receive a passing notice and I am done.

It was erected under contract for the "Kings County Water Supply Company," at Gravesend, N. Y., by the "Robinson Boiler Works," Boston, Mass. On October 7th, 1886, while being filled

with water, under direction of Mr. Robinson, it burst and fell a total wreck. The pressure guage at the works showed 102 lbs. This stand-pipe was circular, made of steel-plates 16 feet diameter to a hight of 70 feet, contracted at that point by a conical frustum 25 feet high to a diameter of 8 ft., which it held to the top, for 155 feet, making a total of 250 feet in height, bearing the proud position of being the tallest stand-pipe in the world. The bottom plate was $\frac{7}{8}$ inch steel, cut in quadrouts and united with 5 inch lap-joints of 1 inch rivets staggered, and of 17 feet diameter. The foundation was 17 feet deep; base, 33 feet diameter at bottom, by 18 feet at top; made of concrete rubble and broken stone. Lower half of Rosedale cement and upper part of Portland, surrounded by a concentric ring of brick masonry.

The steel plates made up 5 feet from centre to centre throughout. There were 6 plates in the circle of 16 feet diameter and 3 where it was 8 feet. The lower or first course of 5 feet $\frac{7}{8}$ steel was to be connected to bottom by 6x6x$\frac{7}{8}$ inch angle-iron, flanged, turned out. The next 30 feet $\frac{3}{4}$-inch; then 15 feet $\frac{5}{8}$-inch; all made up with 3 rows rivets in vertical seam and 2 rows in the horizontal seams; next 20 feet $\frac{5}{8}$, making 70 feet of 16 feet diamter; then 25 feet $\frac{5}{8}$; taper from 16 to 8 feet; then 5 feet $\frac{5}{8}$, first course above taper; 30 feet $\frac{1}{2}$; 35 feet $\frac{5}{8}$; 30 feet $\frac{5}{16}$; 30 feet $\frac{1}{4}$; 35 feet $\frac{3}{16}$. All the plates were to be steel stamped 60,000 T. S. All vertical and horizontal seams above the first 50 feet double riveted with sufficient lap to make a good job.

On the outside were two balconies and the pipe ladder. Of the 12 guys—of 1-inch wire rope—6 were fastened to a welded collar 8x$\frac{3}{4}$-inch, secured 100 feet from the bottom, and the circle of anchorage was 80 feet from centre of base of tower; and 6 secured 225 feet from bottom and anchored 150 feet from centre of base. The points of anchorage in the two circles alternating. The guy anchors were 3½-inch iron rails, each imbedded in concrete 6x4x8 feet deep.

The joining of the taper section with the verticals above and below the frustrum were strengthened and stiffened with 12 wrought 4x4 T irons. The 25 feet of top was strengthened by 3x3 angle iron and a ring of angle iron at top.

The photographs herewith show the tower before and after the catastrophe, and serve to illustrate the theory of its destruction. At the 95-foot level, or top of the frustum, the parting is complete around the circles and along the upper line of rivets. At the 60-foot circle, or two sheets below the base of the frustum, the fracture was complete around the circle through the riveted section similar to the other. The frustum lay complete with two circles of plates of the 16-foot cylinder attached to it, as shown in the photograph. The edge of the 60-foot circle lay within a foot of the foundation In very few cases are the rivets sheared or torn, and the bolts held to either one or the other broken parts. Seventy-two plates were represented below the 60-foot level. These were shattered and scattered into thirty or forty pieces. The largest, containing fifteen plates, weighing about seven tons, was flung sixty feet northwest of the tower. The steel angle-iron that connected the base plate to the first course vertical was completely torn off in the angle around the circle. The fractured surfaces of the steel were scolloped or striated in form on the riveted lines, and this was true of almost all the fractured edges of the wreck.

There are two flaws to be seen in the fallen plates, one has been checked from spreading by rivets made up in the plates at each end of the scar. (This was undoubtedly done in cold blood to keep the fracture from spreading.) Another scar six inches long extends from the edge of the plate in a zig-zag way into the plate. Marks of a caulking tool show on each side of it.

None of the guy ropes at the tower end were severed. Two iron rail anchors in the large circle to W. S. W. and S. S. W. were broken, and also one in the smaller circle west.

The events in this explosion were progressive. The tower was being filled by order of Mr. Robinson, and he was about to ascend in a cage on the outside to do some caulking. The water was within ten feet of the top. On examination I am convinced that the first burst occurred on the north side of the 14th course, which is one course below the base of the frustrum at a height of 65 feet. This bursted plate shows distinct striction. It is laid open like a door on hinge standing half ajar. The fracture was on one plate from the end of the plate to one half its length. The rupture coursed along the inner rivet line on the vertical as well as along the upper and lower horizontal inner rivet lines.

A gushing hissing noise followed the explosion, a surging crash, and all was over. The force of water through this aperture and against this half opened sheet, acted as a shaky rudder to give a centrifugal fling to the structure. Instantaneous vibration throughout shook it to its foundation, twisting the cylinder on a vertical axis, ripping the lower seams, rending the unhomogeneous plates into fragments, sending them to the positions they now occupy on the field. The entire upper part, above the 60 foot circle, fell vertically, with a rotary movement from west to east, striking the bed plate on the north-east section and careened over, E. N. E., breaking or snapping off at the 95 foot level on the rivet line, as before described, by the blow on the ground. The foundation remains intact. The elastic limit of a homogeneous steel was not passed.

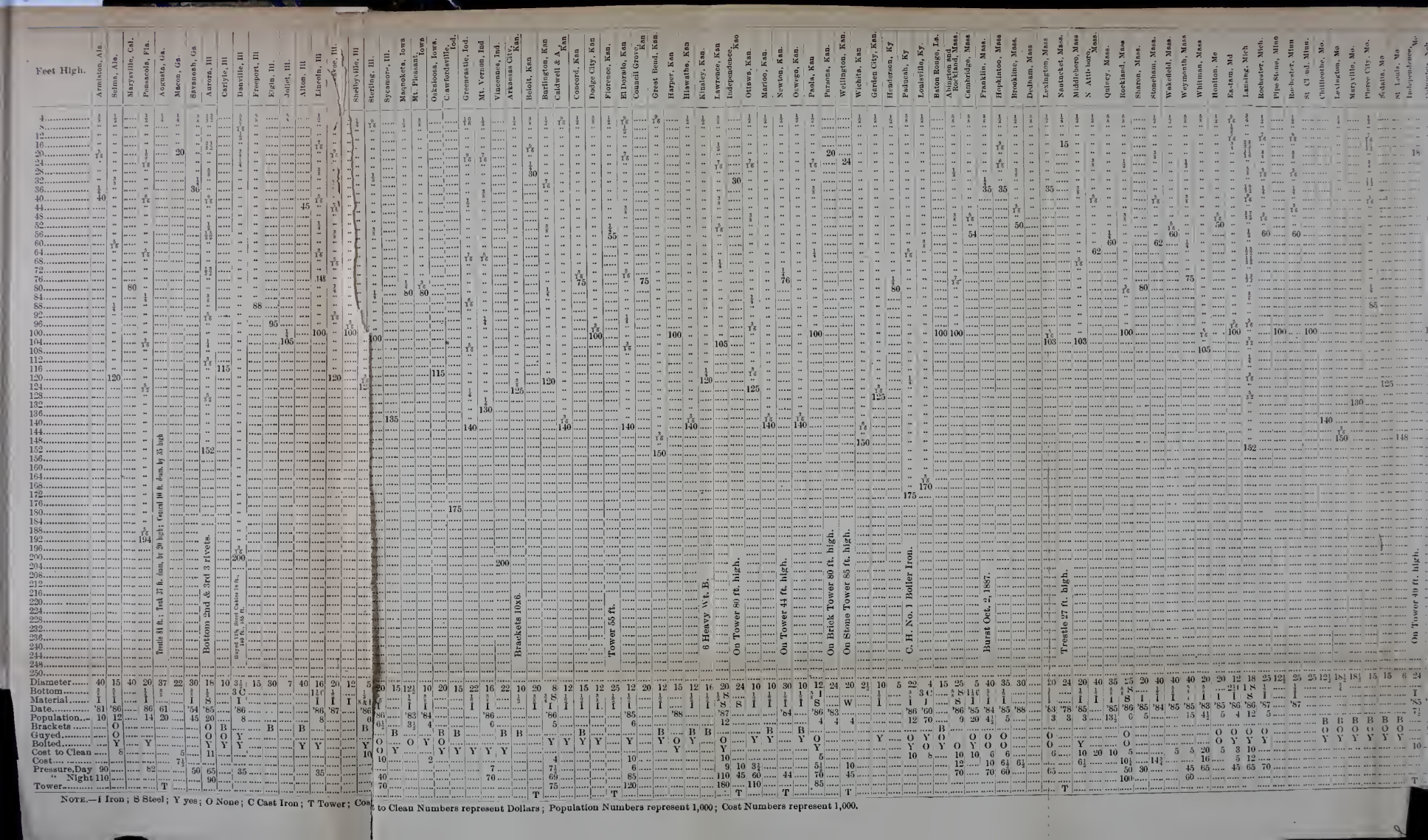
Messrs. Schoenberger & Co., of Pittsburg, Pa., writes me that: "they did not furnish all the sheet plates and that it was not proper for the builder to put the brass plate reading, "Schoenberger & Co.'s steel, Pittsburg, Pa. Tensile strength 60,000 lbs. *on the stand-pipe.* The *quality* was *ordinary tank steel.* We always decline to put our name to ordinary tank steel, fearing that it might be used for boilers or purposes for which we would recommend a better grade. We never heard of a stand-pipe of such an extraordinary height as 250 feet."

In conclusion, assuming that the first rupture occurred in the first or lower ring and the pressure 100 pounds to the square inch, the strain on each inch of height of the plate would be

$$\frac{16 \text{ ft.} + 12 \text{ in.} + 100 \text{ pounds}}{2} = 9{,}600 \text{ pounds.}$$

And this plate $\frac{7}{8}$ of an inch thick, would make the strain per square inch $= 9{,}600 + \frac{8}{7} = 10{,}970$ pounds. The rivet pitch being $3\frac{1}{4}$ inches and the rivets one inch makes the actual strain

$$10{,}970 + \frac{3\frac{1}{4}}{2\frac{1}{4}} = 15{,}850 \text{ pounds.}$$



NOTE.—I Iron; S Steel; Y yes; O None; C Cast Iron; T Tower; Cost to Clean Numbers represent Dollars; Population Numbers represent 1,000; Cost Numbers represent 1,000.

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If the sheet metal was rolled cold, and if the holes were punched cold, these must have been elements of weakness, and this weakness would increase with the thickness of the plates used. To illustrate, imagine Fig. A to represent a curved metal plate.

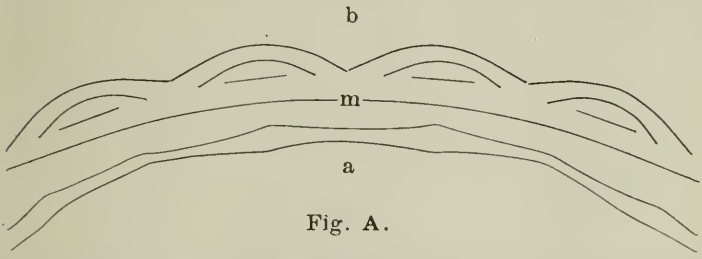

Fig. A.

If this plate is thin the compression of the inside surface a., and the extension of the outside surface b., when rolled will be little, but as we increase the compression and extension of the inside and outside parts, until with an exceedingly thick plate the inside a. would wrinkle or pucker, and the outside b. would crack open or become so weak from compression and extension that they would resist but little strain. Punching leaves the metal around the hole in a strained state, therefore the only safeguard is to drill them. Close inspection is necessary to see that steel is homogeneous, fibrous and ductile. But until steel is made as ductile and fibrous and workable and sure as iron, it cannot be given preference to iron, or even considered as good for structural purposes.

For the theory of Wind-strains, Tendency to Slide and Overturn, Material, Riveting, Pressures, Factors of Safety, Grades of Metals, Limiting Depths of and Thickness of Metals, &c., I refer you to the incomparable work of J. I. Fanning's Hydraulic and Water Supply Engineering.

MR. FULLER:—I would like to ask Mr. Stephens, Mr. President, if he does not think that this conical reduction in the sheer of the stand pipe had something to do with its collapsing or giving way.

MR. STEPHENS:—No, sir; I do not think it had anything whatever to do with it. It was braced on the inside by angle irons, running above and below the frustrum, and they were not broken in the least, but the rivets all parted. As I said, the rivets remained with one piece or the other, but they remained intact. One was broken by the blow on the ground, and the other was broken by the twisting motion. I am quite certain that the rivets were too small for the work. In cold weather we have never had any trouble with stand-pipes, so long as we pumped into them two or three times a day. For that reason I never apprehend any danger from ice.

MR. FULLER:—It seems to me that there must have been an upward thrust on this inclined portion of this stand-pipe—a thrust against what the horizontal projection of that inclination would be—and that the iron below this conical reduction had not only to sustain the pressure that would be due to the height of water at that point, tending to push it out and tear it apart in that way, but that there was also a tendency to tear it apart by the thrust against this inclined portion, and that if the stand-pipe had been a continuous stand-pipe of the same diameter top and bottom, or if there had been a gradual inclination, it would not have given way.

MR. STEPHENS:—No, sir, that had nothing to do with it. If it had been of iron or ductile it would have been intact to-day I believe. You are right as regards the strain on the conic portion, but the specifications were such as would obviate all that. It was made stronger in consequence, and braced as a precaution.

MR. FULLER:—Was it made strong enough to stand anything but the pressure that would be due to the height of water above successive sheets, the horizontal strain?

MR. STEPHENS:—It was, as we thought.

MR. FULLER:—I understood at the time that it was thought that it was not made strong enough to stand anything but this horizontal pressure, and that no provision was made for anything else.

MR. STEPHENS:—Oh, certainly, that was done, but I attributed the accident solely to the quality of the material.

MR. DUNHAM:—Mr. President, I would like to inquire in regard to this stand-pipe, if, before it was quite filled, the outside of the pipe all the way around did not turn up from the foundation; and after that did they not put in the braces that Mr. Stephens speaks of on the inside of the pipe?

MR. STEPHENS:—There were braces put in afterwards as a precaution; yes, sir.

MR. DUNHAM:—Was it not because the outside of the pipe all the way around turned up from the foundation?

MR. STEPHENS:—There was a little tremulous motion there that would be perceptible by placing between the bottom of the stand-pipe and the foundation a knife blade. You could feel it on the knife blade.

MR. DUNHAM:—Then there was an upward strain on the outside of the stand-pipe sufficient to lift the weight of the water?

MR. STEPHENS:—It would lift it, as I say, so that you could thrust a knife blade between the bottom of the stand-pipe and the foundation. But, for fear that this might increase, we adopted the putting on of these braces.

MR. HAGUE:—How were these braces arranged, the braces at the bottom of the stand-pipe?

MR. STEPHENS:—The brace was prepared of angle iron and fastened to the inner side of the stand-pipe above and below the cone. Then afterwards there were put in braces from the bottom, fastened to the second and third sheets, in a diagonal way.

MR. HAGUE:—It strikes me that braces inside of a stand-pipe that is circular in form might defeat the distribution of the strain. The strain in a circle, of course, would bring it in a tensile direction on the metal; but if you put a brace across a section you might tie it at a point where it wanted to give, and make a cross strain on the metal, something of that kind, and with a low quality of tank steel it might have been up to 70 or 80 tensile strength in spots. That might account for the breaking.

MR. STEPHENS:—This breaking occurred on the second plate, sixty-five feet from the top. That was distinctly seen by men upon the ground. The building was off about six hundred feet, and there were perhaps twelve or fifteen men who witnessed the affair. The water was gushing out of that place, and that caused this vibratory motion and this turning of the thing upon its axis, and it all went over.

MR. HAGUE:—How do you account for it?

MR. STEPHENS:—I have already said; shall I repeat it?

MR. HAGUE:—I mean in short terms. The plate was cracked I suppose?

MR. STEPHENS:—Yes, sir. The plate I speak of, on the sixty-five foot level, first gave way and it opened in that manner, and this water rushing against this place caused the whole thing to tremble and vibrate from top to bottom.

MR. HAGUE:—Was there any cross brace near the place where the breakage was?

MR. STEPHENS:—No, sir, none.

MR. FULLER:—I would like to ask Mr. Stephens if he remembers roughly or approximately how many of these stand-pipes which he has tabulated have an interior pipe, a rising pipe as it is sometimes called. I think he said that he thought it was better not to have anything inside of the stand-pipe.

MR. STEPHENS:—The one at Augusta, Georgia, was extended in this manner in 1882. I thought I built the first one myself, but that anticipated me a year I find; I have built two in that manner. As the Shoenbergers wrote me, they did not furnish all the steel for this stand-pipe, which shows that there were two qualities of steel in it; I am sorry that I have not brought a sample with me; I could have illustrated it very nicely. The one I speak of in Augusta is a perfect success; I have a drawing of it which I can show you.

MR. JUDSON:—You speak of extending the height of the stand-pipe afterwards?

MR. STEPHENS:—Yes, sir.

MR. JUDSON:—How is that done; from the inside?

MR. STEPHENS:—From the inside or the outside. Of course it is easier to make them now than it was years ago. I recollect that we put a very expensive staging around the first stand-pipe I had built, costing about $800. Now you can put up a staging for $25, or you can put a cage inside.

MR. JUDSON:—We built one at Sandusky and used boats on the water. I have been very much interested in this discussion, inasmuch as at Sandusky, Ohio, we have a stand-pipe which is twenty-five feet in diameter and one hundred and eighty feet high above the rock, and inside of this is placed a smaller stand-pipe, rising forty-five feet higher than the large stand-pipe. The centers are the same for both stand-pipes. This obviates the difficulty that Mr. Stephens spoke about in regard to using a stand-pipe for both domestic and fire purposes. In case of fire, by closing one gate we pump the water directly into the higher stand-pipe and raise it up to the 225 feet, which gives approximately a pressure of 100 pounds to the square inch. The large stand-pipe is provided with a check valve just outside so that the water cannot come back into it. It has been in use about eleven years and

we find that it works very satisfactorily; it has given us no trouble at all. We have had some little difficulty in regard to the ice; that is the worst objection I see to that form. The ice has a tendency to collect around the smaller pipe, but by simply rigging a steam pipe up on the outside of the pipe, turning it over on the inside and blowing steam for two or three days during very severe weather we can loosen the ice from the smaller stand-pipe, and it never has done any damage to amount to anything. The smaller pipe is a guy to the larger one. There are cross braces on the top of the larger pipe, tying them to the smaller one, so as to strengthen it or to brace it from swinging either one way or the other. We do not have any cast-iron or wrought-iron bottom; it is simply set into the natural surface of the rock, with a cast-iron shoe, which is leaded and caulked in; and then there are anchor irons, some inch and a half in diameter, I believe, running about eight feet into the rock and leaded in. About a year or a year and a half ago we had it cleaned out, and for two days it was empty, and, although there was quite a high wind, I could not see that there was any more movement in the stand-pipe than when it was full.

MR. STEPHENS:—I am glad you gave me the height of that stand-pipe. I was asked the other day which was the largest stand-pipe in the world, and the builders wrote me that they thought the next to the largest was the one at Houston, Texas, and the largest at Sandusky. From information, I will state then, that the stand-pipe at Houston, Texas, is the stand-pipe of largest capacity in the world, 150 feet high by 30 feet in diameter. I gave those dimensions myself. The first one at Houston, 74x20, gave way from the insecure foundation, or foundation of cross walls. I insisted on that height for that stand-pipe, and very positively stated it. I got a letter from the makers the other day asking whether or not it was the largest stand-pipe in the world, and I will very cheerfully reply to them now. I am very much obliged to you.

Adjourned until 8 o'clock p. m.

EVENING SESSION, WEDNESDAY, April 18th, 1888.

The Association met in the City Council Chamber at 8 o'clock.

Vice-President Warner, of the Civil Engineers' Club of Cleveland, was called to the chair, and introduced Mr. John Whitelaw, Superintendent of the Water Works of Cleveland, who read the following paper:

CLEVELAND WATER WORKS.

BY JOHN WHITELAW, C. E.

Gentlemen and Members of the American Water Works Association:

I have been invited by the resident members of your Committee of Arrangements to prepare a brief description and history of the Cleveland Water Works, and to read the same at this meeting.

While I have been identified with these works two-thirds of the period of their existence, and am, therefore, familiar with nearly every detail, I must confess that when called upon to write a description and give a historical sketch, the task seems very much greater than when the subject was first suggested to me, and I make the attempt with no small degree of misgiving as to my ability to do the subject justice.

The first definite action taken to procure a public water supply for the City of Cleveland, was the appointment of Mr. T. R. Scowden as Engineer, who on the 28th of February and afterwards in June, 1853, reported plans and estimates. Of three plans submitted, the one locating the works west of the mouth of the river was adopted, the water from this point being less liable to contamination by the discharges from the river. The work of construction was commenced in 1854, and lake water let into the mains for the first time on September 24th, 1856.

The reservoir had a storage capacity of six million gallons, and was built on the top of an artificial bank raised 22 feet above the street level. The engine house, boiler rooms and stand pipe tower, rested on a foundation laid on a solid timber raft, that in turn was laid on quicksand. The pumping machinery consisted of one pair of purely Cornish beam engines, exact duplicates. The steam cylinders are 70 inches diameter with a stroke of 10 feet. The double beam is 29 ft. 10½ ins. between end centers; width across the fulcrum 6 ft. 8 in. Weight of beam with center shaft is 40 tons. The arms of the beam are unequal, the longer end connecting with steam cylinder being 15 ft. 11. in.; the end connecting with the pump plunger is 13 ft. 11½. in. The pump plungers are 30 inches in diameter, and have a stroke of 8 ft. 9 in., the displacement for each stroke being nearly 321 gallons. The maximum speed, pumping against a head of 166 feet in the stand pipe, was about 11½ strokes or 100 feet per minute when running a single engine.

The boilers are of the Cornish type, 6 feet in diameter and 30 feet long The best duty these engines have ever shown is about 50 millions Water was delivered to the reservoir through a 24-inch pumping main about 2,200 feet long. From the reservoir to the central part of the city water was brought by a 20-inch pipe. This pipe furnished all the water used east of the river until 1866

The works as originally completed, consisted of one pair of Cornish engines, having a daily capacity when coupled together and run continuously at the greatest speed they could attain when so coupled, of about 7½ million gallons.

The pipe system, including three miles of mains from 16 inches to 24 inches, was only 13 miles, and one-half of the small pipe was, 4 inch.

The number of stop gates was 130 and of fire hydrants 44.

Water was taken from the lake 300 feet from the shore and one mile west of the river, and conveyed to the pumps through a brick aqueduct of oval form 4x5 feet and about half a mile long. The works when completed according to the original design of the engineer, cost $526,713. Mr. Scowden in his final report to the Board of Trustees says: "The capacity of these works to deliver water is greater than the originally estimated wants of the population the works were intended to supply, which was for 100,000. They are, however, capable of supplying at least 200,000 inhabitants with an abundance of water. By an enlargement of the main pump barrel and plunger to each Cornish engine which was contemplated in the plans, the supply may be increased to an unlimited extent. No fear can be entertained that the present water works in the next fifty years will fail to yield a superabundant supply of water." In 1867, just after the completion of the original works, the average consumption of water per day was 1,908,000 gallons. Four years later the consumption had doubled, and the rate of annual increase had reached 25 per cent. In 1870 the work of building the lake tunnel was commenced; the purpose of this was twofold: first, to secure a supply of water uncontaminated by the discharges from the river, which was then as now the outlet of many main sewers, as well as being the channel for conveying to the lake the refuse from the many oil refineries and slaughterhouses situated along its banks and tributaries. The second and equally important object was to secure an increased supply of water. It was found that during low stages of water in the lake, the quantity delivered to the pumps was not equal, at times, to the capacity of one engine, and the rapid rate of increase in demand admonished the Board of the danger of a water famine in the near future unless the supply was increased. Chicago about this time had completed her first tunnel, and investigations of the formation underlying the lake in front of us, showed substantially the same kind of clay, and it was decided to adopt the plan so successfully carried out by our western neighbor. Preliminary work was commenced in the latter part of August, 1869, and after battling with many difficulties a tunnel five feet in diameter and one and three-fourth miles long was completed and put in use about the first of March, 1874, at which time the daily average consumption had reached about 5½ million gallons, with a maximum monthly use of $6\frac{8}{10}$ millions. In July, 1874, just 18 years after the original works were completed, a new

pumping engine of 10 million gallons daily capacity was added to the plant that was to furnish all the water required for fifty years. Two years later another engine of the same size was added; thus in 1876, just twenty years from the date of the completion of the first plant, the machinery required for making certain a supply of water in times of greatest demand was of a capacity more than three times greater than was supposed to be ample for fifty years.

The third new engine was added in 1882, and a fourth in 1884, leaving the pumping capacity at this time exclusive of the original Cornish engines 40 millions, with two 15 million Knowles engines now in process of erection. These will doubtless be ready for service by July next, when the total capacity will be 70 million gallons daily.

Main pipes were of course necessary to take the water from these engines. For the supply of the east side of the river, one 16 inch, one 20 inch and two 30 inch mains are in use, with one 30 inch for the supply of that part of the city west of the river. In crossing the river three wrought-iron pipes are used, two of them being 36 inches and one 33 inches in diameter. They are all half-inch thick, double riveted, and are from 220 to 270 feet in length, and dip by easy curves about 25 feet below the water line, trenches having been excavated in which to place them.

In 1882 twenty acres of land was purchased and appropriated on which to build a reservoir for the supply of the lower and average elevations of the older portions of the city, and a lot on which to place buildings and machinery for elevating water to levels that could not be reached with a head suitable for the northern and western part of the city. At the same time another tract of ten acres was purchased distant about 100 rods east of the city limits, on which to build a reservoir for a high service system. The head of water in the low service reservoir is 170 feet, that in the high one being 325 feet above Lake Erie, or a difference of 155 feet. The dividing line between the high and low service systems being fixed arbitrarily on the 120 foot contour line, gives a maximum head for the upper service of 205 feet, and a minimum head of 20 feet. The minimum head in the low service was made greater than in the upper one for the reason that only a very limited area is embraced within the 305 foot contour line.

The low service, or what is designated Fairmount Reservoir, (named from one of the streets passing it) consists of two distinct basins of unequal size, made to conform to the outline of the land. The capacity of the larger one is 47 million, and the smaller one 33 million gallons.

The high service reservoir covers nearly ten acres, and has a storage capacity of about 38 million gallons. Water is pumped to this reservoir from Fairmount Reservoir by the old Cornish engines that were removed from the lower pumping station to a building erected for their reception at the lower reservoir. The main leading to the upper reservoir is 30 inches in diameter, and 13,000 feet long. The total number of miles of pipe in the two systems on the first day of January last was 251¾, of which 15 miles is in the high service system. We have about 5000 stop gates in both systems, and 2517 fire hydrants.

The number of service connections at this time is about 25,000, We have in use 1,525 water meters and registers, and during last year the average quantity of water measured per day was nearly 5¼ million gallons.

The total water pumped in 1887 reached a daily average of 22¼ million gallons, while the average for the month of July was nearly 32 millions. The minimum monthly average was in April, when the quantity was only $17\frac{7}{10}$ millions daily.

On the 24th of March last a contract was awarded for building an additional tunnel from the inlet crib to the lower pumping station. This tunnel will be 7 feet in diameter and 9,200 feet long, and is calculated to deliver 110 million gallons per day, with a head of 13½ feet on the suction pipes. In estimating the delivery, due allowance was made for the inequalities of surface in the masonry, as well as for the angles at the shafts. When this work is completed the daily delivering capacity of the two tunnels will be over 150 million gallons. The red lines on the map show the territory embraced within the high service district, and the blue lines indicate the main pipe lines as well as the existing and proposed tunnel.

A MEMBER:—What revenue do you derive from your works here?

MR. WHITELAW: The income?

A MEMBER:—Yes, sir.

MR. MADISON, (Secretary of the Cleveland Water Works Department):—About $400,000.

MR. TUBBS:—Mr. Whitelaw, I would like to know, if you have it in mind, about the rate in growth in population of the City of Cleveland for a period of ten or twenty years back.

MR. WHITELAW:—The population of Cleveland in 1796 was 4; in 1830 (by the first U. S. census) the population was 1,075; in 1840, 10,135; in 1850, 17,645; in 1860, 43,838; in 1870, 92,825; in 1880, 160,140; in 1885, by police census, 205,446; in 1886, by police census, 214,013.

MR. TUBBS:—I think I asked you the question individually; I would like to have you answer it publicly if you can. About what is the average consumption of water per head per day?

MR. WHITELAW:—It is about 90 gallons. I think a little over 90 gallons.

MR. TUBBS:—Is that 90 gallons for the whole population?

MR. WHITELAW:—Yes, sir, that is for the whole population.

PREST. FANNING:—Mr. Chairman, I undestand that Mr. Whitelaw made some experiments with the use of crude oil in his furnaces. I know many of our members are very much interested in that question. Perhaps he can give us some facts that will be of value to us. If so, we will be very glad to listen to them.

MR. WHITELAW:—During the fall of last year we experimented for some time with crude oil as a fuel, and I made a memorandum at the time of a special test that was made during fifty-four hours, two and a quarter days.

"The following calculations show the relative value of coal and petroleum as fuel for making steam, as determined by trial with oil at the Water Works pumping station on Division Street, beginning at 1:45 o'clock P. M. September 30th, and terminating at 7:45 o'clock P. M. October 2nd, being fifty-four hours or 2¼ days:

COAL FUEL.

Coal consumed, average (the average was taken for the year 1886), 3,000 lbs. per 1,000,000 gallons, (taking the same quantity of water that was pumped with the oil), 33¾ tons, at an average cost of $1.35 per ton, making the cost for coal	$45 56
Labor, one fireman 54 hours, at 23 cents an hour	12 42
Coal wheelers, 2¼ days, at $1.66⅔	3 75
Hauling ashes, one day	2 75
Total cost of pumping 22,500,000 gals. water	$64 48

OIL FUEL.

Oil consumed, 6,131 gallons at 1¼ cents per gallon	$76 64
Labor, one man ½ of 54 hours, or 27 hours (that is assuming that one man would attend two batteries of boilers just as easily as one battery), at 18⅓ cents	4 95
Total cost of pumping 22,500,000 gallons	$81 59

"That sum, less the expense of the same work using coal, shows a difference in favor of coal of $17.11, or a per diem saving of $7.60. One year, for one battery of boilers, $2,274. Per million gallons, 75 cents. One year pumping 20,000,000 per day, $5,475. A saving in favor of the use of coal.

"With coal at $1.85 per ton, the cost of making steam would be about the same as with oil at the price stated above."

At the same time we made an evaporation test.

"The following evaporative test of oil fuel was made at the West Side pumping station of the Water Works, beginning September 30th at 1:45 o'clock P. M., and terminating at 7:45 o'clock P. M. October 2nd:

Duration of test, 54 hours.

Water evaporated, at a temperature of 138 degrees, 10,058 cubic feet.

Weight per cubic foot, 62.39 pounds.

Total weight, 627.519 pounds.

Gallons of oil used, 6,131, at 7¼ pounds per gallon, 44,450 pounds.

The result in evaporation, taking those elements, gives 14,117 pounds of water evaporated for one pound of oil, the temperature of the water being 138 degrees."

MR. C. G. FORCE, (Late City Civil Engineer of Cleveland):—I would like to ask what was the price of oil?

MR. WHITELAW:—1¼ cents a gallon.

MR. FORCE:—That would be about 62½ cents a barrel, and oil at the present time, I understand, can be purchased for from 17 to 20 cents a barrel.

MR. WHITELAW:—That was the price we paid for it. We did not include, however, any interest on plant for feeding the oil. The price named by Mr. Force was at the wells; freight should be added for prices in Cleveland.

MR. TUBBS:—Mr. Whitelaw, a gentleman of the Association asks me to inquire if you are able to give the total cost of your water works plant up to date.

MR. WHITELAW:—Our Secretary is present. I think he can give the figures more closely than I can.

MR. MADISON:—Substantially five millions.

MR. TUBBS:—I desire to ask another question; it is a little out of the line of this discussion perhaps. I suppose bonds were issued for the construction of the works?

MR. WHITELAW:—Yes, sir.

MR. TUBBS:—Are you providing a sinking fund for paying those bonds?

MR. WHITELAW:——Before the water works were built the city subscribed for stock in several of the railroads leading into Cleveland, which were built or being built, and it happened to be a good investment. The city "went in on the ground floor," as the saying is; the stock was watered a good many times afterwards, and from a very small original amount, an investment of a few hundred thousands, the city got somewhere in the neighbor-

hood of a million and three quarters. That money was pledged for the redemption of the original bonds that were issued for the water works. The total debt of the water works at the present time is about $1,750,000, and $950,000 of that is already provided for.

MR. TUBBS:—There is a yearly provision being made for a sinking fund now from your net receipts?

MR. WHITELAW:—No, sir.

PRESIDENT FANNING:—We remember Mr. Whitelaw had some pretty serious difficulties in putting his first tunnel out under the lake. I wish he would tell us something about what the trouble was, out of the ordinary run, what he found to be the nature of the soil, and what gave him the most trouble.

MR. WHITELAW:—The nature of the soil under the lake is very similar to that of Chicago, but there seem to be fractures running through it that appear not only in the clay in the lake, but fractures running in the same direction appear in all the quarries through the rock through this part of the State, or in the vicinity of Cleveland. These lines of fracture run from nearly northeast to southwest, and the clay in general was very hard and dry. So that any fracture that came, from whatever cause it did come —probably from the same cause that broke the rock in the quarries through this part of the State---seems never to have closed; and the probability is that our tunnel was not very far from the rock, although borings indicated that at the outer end we were some fifteen or twenty feet above the rock, and about ten feet at the shore above the rock. But water found its way through these seams or cracks in the clay, and gradually cut the clay away and let in quicksand. The only thing we could do in such a case as that was to build a bulkhead. After battling with the quicksand for some time, we built a bulkhead across the tunnel and made a curve around the bad ground. We did that two or three different times. So that the tunnel is not a very straight one.

The next difficulty was out near the inlet. Working in from the outer end, we found considerable soft clay, clay too soft to stand in place while the brick work could be laid. The means adopted to overcome that was a shield, somewhat after the pattern of what I suppose most of you have seen—the "Beach Shield." At the time it was made I never had seen that or seen a description of it. I made drawings for one and had it made here; the shield

was used for about 130 feet, until the soft clay was passed. The brick work was built about sixteen inches in length at a time, two lengths of brick inside the shield, and the shield moved forward by hydraulic rams; after passing about 130 feet the shield was not necessary in any other portions of it.

But the worst difficulty we had to encounter was water, and finally sand following the water through these cracks in the clay.

MR. TUBBS:—What depth is your tunnel below the ordinary surface of the lake?

MR. WHITELAW:—At the shore end it is 78 feet; at the lake end it is about 91 feet below the lake level. The depth of water at the inlet, at the crib, is 38 feet.

MR. FANNING:—Down near the pumping station we noticed a bay. It appears to be an arm extending back from the present channel of the river. Has the river changed its bed there?

MR. WHITELAW, (pointing to a map of the city):—The river at one time came in that direction, and had an outlet there; there was where the discharge was at the time of the early settlement of Cleveland. Vessels could not enter where the present mouth of the river is, but could get out at the other at that time; that is, small, light draught vessels; but this channel was opened, has been improved by the Government, and is made the outlet of the river now.

MR. FANNING:—Did you find any indications of the river channel having crossed your tunnel line?

MR. WHITELAW:—Yes, sir; I think we crossed what was the old channel of the river twice in building the tunnel, but the depth was not as great there as near the inlet, and the clay held in place until the masonry could be put in. The reason for supposing it was an old channel of the river was, that taking the point at the present end of the old river channel and laying down on the map the places that were crossed, showing this soft clay, it would give a very natural channel of the river. It crossed that way, (pointing to map), and back again, and back that way again; so that it was crossed at one time in that direction, and the second time it was crossed the angle was in the opposite direction; and at the same time, in entering the soft clay, it was found on an incline of perhaps eight or ten degrees, and in leaving it the inclination was in the other direction, showing that the channel was in a V shape.

MR. TUBBS:—Is your engine-house foundation on piles?

MR. WHITELAW:—The one on the south side of the street is on piles, and the one on the north side is on timber—a raft—sunk in the mud. The foundation for the boiler-house and chimneys, immediately in its rear, is on piles.

MR. DUNHAM:—Mr. President, I dislike to display my ignorance, but when I look out on the Lake I cannot tell within fifty or seventy-five feet the diameter of the crib, and when I look at that model I cannot tell.

MR. WHITELAW:—That model is just one twenty-fourth the size of the crib; the sides of the crib are 54 feet each; the circumscribing circle is about 90 feet; the depth of timber work from top to bottom is 64 feet. The structure went down into the clay about 13 feet; was sunk, when it was laid, with stone, and the storms operated on it.

MR. FANNING:—Did you lower it by undermining it?

MR. WHITELAW:—No, sir; it went down from the weight that was on it, and the rocking motion that it got from storms.

MR. FANNING:—What was the process of anchoring it, so as to sink it in proper position?

MR. WHITELAW:—When it was built the bottom was caulked, the same as a vessel would be, up to a draught-line of fifteen feet. Sufficient weight was put in it so that when taken to place, by opening gates that were provided in it, it would sink and rest on the bottom itself. The weight of stone that was put into it, when it was towed out to place, was sufficient to sink it.

MR. FANNING:—What is the depth of water where it is sunk?

MR. WHITELAW:—38 feet. The vessels were lying ready to go out and lie along the five sides of it and throw stone in as soon as it was sunk in place; so that there were in the neighborhood of a thousand tons of stone put in it, in addition to what was in it when it was towed out the day it was sunk: but that did not fill it, and the storms that followed closely after rocked it so that it worked down into the clay.

MR. FORCE:—What means did you use to check the settlement of the crib?

MR. WHITELAW:—We put rip-rap on the outside—filled up with pier stone against the five sides of it until the weight outside balanced it.

MR. TROY:—What provisions, if any, are made to protect it from anchor ice.

MR. WHITELAW:—We have never been troubled with real anchor-ice. Two years ago last January we had a heavy snowstorm, with the temperature of the water very near the freezing point, down to about 32 degrees, and at the same time the snow was falling thin ice was forming on the Lake, and the ice and snow together formed a compact mass of slush running out to the crib or beyond it. The temperature changed, and the wind changed, and that mass, with these floating balls of snow, encased in ice, floated out and broke. Of course, the ice floating out breaks against the crib and parts. At the same time water was being used here lavishly to prevent pipes from freezing, and the suction was unusual, and these balls of snow, encased in ice, were drawn in, and they closed the inlet to the shaft. At the time that happened there was a timber cap laid over the top of the shaft and bolted down to the top, to prevent anything from falling from above into the shaft; the openings underneath were 2½ or 3 feet by 5 on two sides, allowing the water to pass in, and these balls of slush choked those inlets. But anchor-ice we never have had. The bottom of the inlet into the crib is 34 feet below the surface of the Lake, and there has never been any indication of anchor-ice there at all. We once had the same condition of things occur in the old inlet before the tunnel was built. The same conditions prevailed before the stoppage that did before and during the stoppage at the tunnel: We had a similar snow storm, under similar conditions of temperature, and the aqueduct filled with this slush for several hundred feet in length.

MR. FANNING:—Is the interior wall caulked?

MR. WHITELAW:—It was caulked up to a line to allow the crib to float with its load. I think it was about fifteen feet from the bottom up that it was caulked. The rest of it is just the timbers lying one upon another, without any provision made to prevent water from getting in.

MR. MAXWELL:—What means do you adopt for getting rid of the slush when it enters the tunnel?

MR. WHITELAW:—Well, since this last occurrence we have placed a boiler with a double steam pipe—that is, a large pipe with a small one running inside of it—to raise the temperature at any point we desire to. We have never had occasion to test it in a practical way, but we tested it on floating ice that was in the well last winter, and it melted that off in about five minutes.

MR. MAXWELL:—Did this obstruction last long when it occurred?

MR. WHITELAW:—Yes, sir; it was thirty-six hours before we could get relief.

MR. FORCE:—How are your pipes arranged in the water?

MR. WHITELAW:—It is a small pipe run inside of a large one.

MR. FORCE:—Surrounding a coil of pipe?

MR. WHITELAW:—Yes.

MR. DUNHAM:—Does the model represent the whole plan of the crib?

MR. WHITELAW:—Oh, no; it only shows four or five courses of it. That was made to assist the contractors in bidding on the work, more than anything else.

MR. FANNING:—I understand you are just about to begin the building of a new tunnel. Is that so?

MR. WHITELAW:—Yes, sir.

MR. DUNHAM:—The two tunnels will not be close together?

MR. WHITELAW:—Oh, no, sir; about thirty feet apart at the inlet and sixteen hundred feet at the shore line.

MR. BABCOCK:—Was the ground originally level?

MR. WHITELAW:—Yer, sir.

MR. BABCOCK:—You did not have to adopt any means of making it level?

MR. WHITELAW:—No. We had a diver go down and make the examination. The ground was perfectly level. In fact, the inclination of the bottom of the Lake is about as true as an engineer would stake it out for a uniform grade.

MR. FULLER:—I would like to ask if those new shafts will be bricked up to connect with the brick-work of the tunnel?

MR. WHITELAW:—The lower part of the shaft is lined with brick-work, and the bottom of the iron lining is not supposed to go down as far as the top of the tunnel. The expectation is to find clay there hard enough and firm enough to remain in place, so that excavation can be made below the bottom of the castings, to the level of the tunnel, where a curved connection between the shaft and the tunnel will be made—a curve having a radius of about four feet, so as to cut the corners off.

MR. FANNING:—What is the size of the pocket that you are to use for the new tunnel?

MR. WHITELAW:—Do you mean the pocket in the crib?

MR. FANNING:—Yes, sir.

MR. WHITELAW:—It is about eleven feet and a half.

MR. FANNING:—Are you to cut some inlets into that?

MR. WHITELAW:—Yes, sir; inlets will be cut from the outside about twenty feet below the surface.

MR. FANNING:—And do you have any gate arrangement by which you can close those?

MR. WHITELAW:—No, sir; that is one thing that I wanted to avoid. In consultation with Mr. Chesbrough before building our first tunnel he advised me not to use any gate in the shaft, but to take the water directly over the top, having a cylinder ready to place on to shut the water off in case it was ever necessary. With our present works we screen the water at the pumping works; we intend now to screen the water at the crib—that is to make a trial of it, and let the crib-keeper clean the screens every day—circular screens in the form of cylinders, giving the whole circumference of the shaft for screening surface.

MR. FANNING:—And you have no fear of trouble through anchor-ice from that plan?

MR. WHITELAW:—Well we may have, but of course we will watch it very closely and if there is any danger they can be very easily lifted off, they are just set on top of the shaft. Of course now we would not suffer imme-

diately if there was a stoppage, because we have a storage of water that would last us, at the present time and for some time to come, at least a few days. At the time our last trouble occurred we had no storage.

MR. FULLER:—About what was the cost of the first tunnel that was built?

MR. WHITELAW:—The first cost was $320,000.

MR. FULLER:—And that was how long?

MR. WHITLAW:—It was 6,606 feet. That included the crib and making connections on the shore with the old aqueduct that is mentioned in the paper. Since the Lake tunnel was completed it has been extended from the Lake shore to the pumping works. The original aqueduct was used in connection with the tunnel for about two years.

MR. DUNHAM:—Does the presence of the crib in the Lake create a disturbance in the water so as to make it turbid?

MR. WHITELAW:—No, I think not. I think that has no effect at all on the water. The generally accepted belief is, that the water is not disturbed down any deeper that the height to which it rises above the general level in storms. The sediment we have is what is raised by storms acting on shallow water. I believe that is the generally accepted belief.

MR. FANNING:—Do you not find some evidence of circulation about the Lake? When the wind is blowing in one direction, say diagonally, a number of days, does it not set a considerable body of water in motion?

MR. WHITELAW:—In a bay that is formed by a projection of the shore, about two or three miles west of us, there is an eddy along the Lake shore; that is, there is a flow of water up the Lake, which I have noticed by repeated observations. I have detected it from the presence of coal oil which is discharged from the river. That was before any works were west of us. I have found coal oil four and five miles west of us out on the Lake, along the shore.

MR. TUBBS:—I suppose the sewage of Cleveland passes into the Lake?

MR. WHITELAW:—Yes, sir.

MR. TUBBS:—It is a delicate question to ask a citizen of Cleveland, or any other city, I suppose, but I desire to know, if possible, whether you have ever discovered that the water at your inlet crib was affected by the sewage.

MR. WHITELAW:—We have at certain times. When the Lake is covered with ice and the spring freshets come without the ice moving out, the water from the river will spread then and go we do not know how far, and the river water at such times does reach the inlet. But those occasions are very rare. Those two conditions have got to come together to make it so.

MR. FANNING:—Does not the breakwater, in its present form, tend to deflect such current as there may be in the Lake?

MR. WHITELAW:—It sets that current out as much farther from where it was before the breakwater was built as the breakwater is.

MR. FANNING:—Does it deflect it in the direction of the crib, or away from the crib?

MR. WHITELAW:—In the direction of the crib. The breakwater is located about half a mile from shore. That of course, carries this shore eddy that much fauther out in the lake. Another thing: We find that since the breakwater was built the reaction of the waves on the crib from the shore is very much heavier and more severe than it used to be. The seas striking the crib now from the shore side are very much heavier than they were before the breakwater was built.

MR. FORCE:—Mr. Whitelaw, have you not made some observations upon the Lake shore that indicate that the general tendency of the current is down?

MR. WHITELAW:—Oh, yes, the general tendency is down.

MR. FORCE:—I was afraid that perhaps your answer to one of the questions would lead gentlemen to think that the main current along the Lake was westerly.

MR. WHITELAW:—The main current is down the Lake. We have proved that very conclusively from sets of analyses of the water that we have had taken this fall, and which will be published in our next report.

MR. TUBBS:—The prevailing winds would affect that, anyway, would they not?

MR. WHITELAW:—They affect the surface water. I do not think they ever affect the water down to the depth at which the water is that taken out.

MR. TUBBS:—But the prevailing wind would carry it it down the Lake?

MR. WHITELAW:—Down the lake, yes, at certain seasons of the year.

MR. TUBBS:—I was perfectly sincere and honest in asking the question. It is a matter of public import.

MR. WHITELAW:—We commenced in July last taking samples of water on four different lines in the lake out to a distance of two miles, taking a sample at four feet below the surface, and at five feet above the bottom every half mile, beginning at a half mile from shore and terminating at two miles out. These were all taken on the same day and the water was put in glass stoppered bottles and sent immediately to the laboratory, where the analyses were made and repeated in each month, choosing the most stormy day that we could find during the month for collecting the water. We found that the general character of the water west of the river was very much better than east of the river. Then, in order to get a standard with which to compare all of them, we took samples out fifteen miles in the Lake in seventy-five feet of water, taken from near the bottom and near the surface, to see whether there was a difference. The analyses of those samples will be shown in connection with the report.

MR. FANNING:—Has that table of analyses been published yet?

MR. WHITELAW:—It is in the printers' hands now. It will be out in the course of a few days, probably. There are graphic tables given showing the different impurities on the different lines where the samples were taken. One set of samples was taken about five miles east of the mouth of the river, the next set of samples was taken about two miles and a half from here, the next set to the west was taken on a line with the present inlet, and the westerly set at the point of land you see projecting in the Lake to the west. The best samples of water that were found, within the two mile limit, were found on the westerly line, that is, at a distance of two miles out, but

the shore water appears to be just as much contaminated as that taken from the line of the crib. That also indicated this current that I speak of; the eddy up the Lake.

MR. TUBBS:—I should like to express to Mr. Whitelaw my sincere congratulations on his very exhaustive report in regard to the water works of Cleveland, and I hope the President of our Association will do it on behalf of the Association, as well as the thanks of the Association to the Engineers' Club of Cleveland.

MR. WARNER:—There has been some inquiry relative to the system of keeping the water works accounts, and to give us light on that subject I will ask the Secretary, Mr. Madison, to favor us with some remarks.

Mr. Madison, Secretary of the water works department of Cleveland, then read the following paper:

WATER WORKS ACCOUNTS.

BY W. A. MADISON.

Mr. President and Gentlemen of the American Water Works Association:

I feel highly flattered in receiving from your Secretary, Mr. J. H. Decker, an invitation to say something to your Society on the subject of water works accounts as they are kept in the office of the water department of the City of Cleveland.

Appreciating very highly the honor done me, and with an earnest desire, even in a small way, to assist in making your short stay in our city one of both pleasure and profit, I cheerfully comply with the request, at the same time realizing my inability to do the subject justice.

There are in the aggregate at the present time twenty-five thousand water takers who pay their bills over our counter twice a year. This number is increasing at the rate of twenty-five hundred a year. How to keep the accounts of this large number in a way that is simple, systematic and plain; how to save time to the public who call to pay, by giving them quick despatch, thereby saving time and labor to the clerks who serve them, are questions which to me, and to some of you in charge of as large or larger departments, questions of the greatest importance.

As a result of sixteen years experience with water works accounts from the time when the number of services was a little over three thousand, I find, that with the methods in use then, it would be almost impossible to handle the business as it is now, unless the present office force was increased three times at least.

The basis of all our accounts, as in all cities, is the assessment or survey of the premises supplied with water under the rules and regulations as provided.

This work is in the hands of four assessors who make daily written reports of all plumbers work, both new and old, to the clerk in charge of assessments, who writes these reports into a book ruled in columns, headed; Date, Assessment No., Con-

nection No., Owner's Name, Street Number, Street, Details of Assessment, Amount, Addition to Same, Deduction from Same. This book is one of permanent usefulness, holding the record of twenty thousand assessments, and taking the place of twenty books heretofore kept.

The service as it is issued being numbered and the assessment as it is entered being numbered, the numbers entered one against the other, makes a complete reference. This system brings all assessments into one book and makes every line in the book count for something. Where premises are re-assessed the new assessment number supersedes the old one

For the purpose of rapid collection, in being able to find a bill of an account on a moment,s notice, an abstract of the assessments is made in the order of streets, the abstract book being ruled in columns showing the Connection Number, Bill No., Name, Transfer to Whom, Premises, Street Number, Street, Amount Semi-Annual Collections, a column for additional assessments and column for date of payment; by duplicating the columns here mentioned the abstract covers the collection for a year, which when footed, plus additions, less unpaid, must agree with cash receipt.

Thus in solid compact form all bills being entered on the abstract, corresponds to all bills that have been received and entered on the cash book and exact balance is produced. By the aid of a numbering machine that, with unerring accuracy, prints or stamps consecutively a number from one to one million, the bills and the abstract of the same are numbered.

Each bill is furnished with a stub numbered as the bill, showing the amount, which when the bill is paid is turned in to the cashier with the money, who arranges the stubs as they are received in numerical order, so that when entered at night labor may be saved in posting.

The number of the bill and amount is all that is entered on the daily cash book.

The posting is done with the numbering machine, and at the rate of five hundred bills an hour.

I will conclude this imperfect presentation of the system of accounts as kept in this office, by taking as an illustration one day's business.

On the 21st day of October, 1887, 1,250 bills were paid, no customer was detained more than one minute, money was received and deposited with the City Treasurer, cash was balanced, bills were entered and posted each to its proper account before the office was closed at night.

To handle so large a number of people in so short a time, to have all the work in its detail finished at night, to reduce the account books from twenty-five to not to exceed four by utilizing every inch of space and in cash books reducing the number from four to one, or rather making one book last as long as four used to, in its being less liable to errors from its exceeding simplicity, the saving of time to the public, whose servants we are, in giving them quick dispatch, the saving in minutes to each amounting to many days to them in the aggregate, are to me practical proofs that there are some merits in the system that may commend themselves to your judgment.

Adjourned.

MORNING SESSION, THURSDAY, APRIL 19, 1888.

The meeting was called to order by the President, at 10 o'clock.

Mr. Charles A. Hague was requested to address the Association on the subject of "Feed Water Heaters and Condensers."

Mr. Hague spoke as follows:

Mr. President and Gentlemen:—I was put down for a paper on "Feed Water Heaters and Condensers," but owing to a press of business I kept putting the thing off till finally I put it off a little too late, and did not get the paper ready. I suppose I owe the Association an apology, or a few words at least, and I have made a few hasty notes on the subject, which I hope you will accept in place of the paper:

Feed Water Heaters.—This is a matter, of course, applying directly to the pumping machinery. It is useless to advocate the use of Feed Water Heaters; almost everybody is aware of the importance of such a thing. The heat developed by the coal in the furnace is to make the steam used in the engine—as we all know, and the greater part of this heat is lost in the exhaust after a very small part of it has done work in the engine. Now, every unit of this heat that can be saved and put back into the boiler in the shape of heating the feed water is, of course, so much clear gain. Theoretically, and from practical experience and observation, I have made up my mind, at least, that the gain in heating feed water is about one per cent. for each ten degrees that the feed water is raised. For example, if from exhaust steam or any artificial means outside of the fire, the feed water can be heated to say 150 degrees above what it would be taken out of the well at, according to my idea we would gain about fifteen per cent. in economy of fuel.

The question often comes up about placing a feed water heater between the low pressure cylinder and the condenser. It has been argued pro and con by a great many people at different times, and it strikes me about this way: That in order to carry a high vacuum, which, of course, increases the economy of the engine, it is necessary to run the condenser pretty cool, and the overflow from the air-pumps from which the feed water is taken would naturally be pretty cool. Now, the question is, to sacrifice a few inches of the vacuum and reduce the economy of the engine in that respect, and to gain economy in

the boiler by hotter feed water. I have tested several large compound engines in which a heater has been used between the low pressure cylinder and the condenser, and I have found that by carrying a high vacuum, and cooling the overflow, say, down to 90 or 96, and then interposing a heater between the low pressure cylinder and condenser, the actual temperature of the feed can be raised to 122 or 125. Now, that gives the engine the benefit of a little more expansion or a little more power from the vacuum, and at the same time gives the same temperature of feed that you would have obtained if you had sacrificed a part of the vacuum. So, under the proper conditions, judging for myself, and of course every man must judge for himself, I believe that a good feed water heater between the low pressure cylinder and the condenser is a benefit, enabling us to carry a high vacuum and at the same time get the heat into the feed water.

In connection with that sort of an arrangement, the exhaust steam from feed pumps, and, in case of an independent condenser, the exhaust steam from that, could be utilized in heating the feed water also. But in heating feed water in that way, of course, it would have to be done after it had passed through the exhaust coil, because the exhaust coil being so much lower than what the steam from the feed pumps would give, it would rob the feed water, instead of gaining anything. So that the general idea would be to have an exhaust heater between the low pressure cylinder and the condenser, use another heater for the exhaust steam from pumps, etc., and join the two somewhere near the boiler. In that way I think we would get the utmost economy in heating the water from the exhaust steam both from the engine and the feed pumps.

Of course, this is a matter that is subject to experiment, and gentlemen here in this Association who have Water Works Engines under their control, I think, would do well to look into the matter and have experiments tried. They could soon find, under their own particular conditions, just what they could do. If they could not get exactly what I have cited here, it would be simply because the conditions would not allow it.

In passing on to condensers, of course it is generally understood what condensers are. The steam in the boiler is shown on the gauge only above atmospheric pressure, but at the time there is one atmosphere of steam, about fifteen pounds to the square inch of actual steam, in that boiler—just as much steam, but not anything showing on the gauge; and the production of a vacuum on the exhaust

side of the piston simply gives us the advantage of that steam which other wise in exhausting into the atmosphere in the case of a high pressure engine we would not get, and the admission of steam into the cylinder of any steam engine and the expansion is made on that basis. Before the exhaust valve is open and while the piston is being driven we really have a pressure of steam in the cylinder that does not show upon the gauge at all, and that takes place whether we have a condenser or not. Now, all a condenser does, it simply to remove a pressure equivalent to the atmosphere, which gives us the benefit of the pressure which does not show on the gauge.

Applying Condensers to Pumping Engines.—It has often been a question in my mind, especially with very small machines, whether it pays to run a condenser on engines say from a million and a half down. Small plants, of course, are just as important to those who own them as large plants are, and to maintain a vacuum in an independent condenser you must run at a pretty fair speed to enable the air-pump to take out the air and water. But at the same time, on direct service especially, your main engines must run pretty slowly, and now the question is, will this steam which is used by the condenser, in connection with the engine running very slowly, present a loss or a gain? The alternative is to shut off the condenser and run the main engine high pressure, and exhaust through a heater into the atmosphere, and I have seen cases where I believe that in shutting off the condenser on those small plants and exhausting directly into the atmosphere, using the exhaust for heating the feed, an economy in the fire-room would be shown. There is no use in forming a vacuum for its own sake. If it costs more to form and maintain the vacuum than it pays you in the saving of fuel, of course we don't want it, any more than we would want any other mistake in economy. But in those same plants, when it comes to a fire, then of course you want the full power of the engine, and the vacuum could be used, and used to good effect. The great trouble in cases of fire sometimes is, a boiler has been running along may be a month very moderately; a fire alarm comes; you want to spur the engine up to its fullest extent; your fires are low and your steam is low, and it takes some appreciable time before you can liven up your fire and hold it, and in that case, of course, the vacuum would very materially assist.

The question of independent condensers and attached air-pumps also presents itself to my mind. I think on

engines of good size, say from three millions upwards—sometimes two millions—three millions anyway—I believe, under most conditions, the attached air-pump would be the best, for this reason: That the attached air-pump is driven by the main engine, and of course the full economy of the main engine is utilized in the horse-power required to drive this air-pump. In the case of an independent air-pump, you are driving it by a high pressure engine, which is very far below the main engine in actual economy, and this is another one of those cases in which you cannot determine except by actual experiment. There may be conditions that could not be laid down. You cannot lay down a cast-iron rule for working engines and boilers. Each one must settle that for himself; but on general principles I should say that it would be more economical to run an attached air-pump on engines of from three millions upwards.

Of course, there are questions coming in about starting and stopping. It is very nice to have a high vacuum. With an independent air-pump you can start it up, produce your vacuum, and when you start your engine she goes right off without having to form a vacuum. But a vacuum forms very quickly in a properly built condenser, and in reservoir service, where you can start off and run at full speed, I believe the attached air-pump would be preferred on engines of a good size.

Where attached air-pumps are used, and where we, of course, would be robbed of the benefit of heating the feed water from the exhaust in the independent pump, we can make use of the drainage from the steam jackets and the feed pump exhausts, which will carry the feed, if properly applied, up to 150 or 175 degrees, which is a pretty good temperature for feed water. I have seen plants with attached air-pumps where the feed could be carried up as high as 175. You see the temperature from the jackets is very high. It is under boiler pressure. It is away above the ordinary boiling point of water at atmospheric pressure. So that, with attached air-pumps on large engines, the jacket water caught automatically and returned by a jacket pump directly to the boiler, together with the exhaust from the feed pump, will give, to my mind, the best effects, enabling you to run your hot well cold, to carry a high vacuum, and at the same time get your feed water up where it ought to be.

Now the question of surface condensers. On high service plants, where water has been already pumped once, there is no question in my mind but what a surface

condenser is the thing required. The amount of water required to condense steam is from twenty to thirty times the weight of the steam itself. If you have pumped water into the reservoir, and paid money for fuel and attendance at the main station, to take that water and use it for condensing steam, to pump to still higher levels, represents a very large wastage. I have figured up a number of places where this wastage, reckoned at the price at which water would be sold in that particular plant, would pay the interest on the entire high service machinery—simply the wastage of water for use in condensation at a certain number of cents per gallon. The quantity run through a condenser is enormous, and of course, if it runs through the condenser and runs away, it is a dead loss. Now, surface condensers get around this completely, by placing a surface condenser in the suction main, which would simply be a large chamber full of tubes through which the steam would exhaust, and around which the suction water would pass, making a very perfect condenser, giving you a high vacuum—I have seen it as high as 28, and over—because, in that case, the steam comes in contact with very much more water than ordinarily, because all of the water passes through this surface condenser, and you would not begin to bring as much water as that in contact with steam ordinarily. So that you get a very high vacuum, and then by these appliances for heating feed water you get the most beneficial results; you pump your high service water with the greatest economy. Anybody that has a chance to try that experiment would be very much astonished at the difference in the cost of the pumpage between wasting water already pumped once and passing that water through a surface condenser, where it is not wasted at all.

But in this matter of surface condensers there is some times—in fact, quite often—trouble with the boilers. You will see at once that in using a surface condenser the cylinder oil, which is carried by the steam, is very apt to be picked up and carried back into the boiler again by the feed pump. The course of the surface condenser is a cycle, and except for leakage there would be no replenishing of water required. But there are unavoidable leakages—a very small percentage of leakage, so that very little outside or new water goes into the boilers. Now, this is the purest of water, and with hard water, where limestone water is used, a surface condenser will pay for itself in the saving of the boilers. But as to this matter of cylinder oil, it seems to cake over the fire on the sheets, and has produced bagging of the sheets repeatedly. I

have seen numbers of cases where it has produced that effect. It is very easily avoided, and is avoided at sea, by simply straining the water, a very simple device by which the feed water is strained and the oil kept back, the pure distilled water going to the boilers. It is very practical. It simply wants a little attention, may be once a month. Perhaps it will run more than a month, but it requires very little attention. Under these conditions, with a surface condenser and feed water strainer, your boilers will have distilled water, and you will run with the utmost economy.

My last note is something about the attention that machinery ought to have. Some times it looks expensive, but competent engineers and a high class of machinery are really conducive to the most economy. I know the outlay looks large at first, but when you come to reckon it up on a ten years' run, if you look at it in the light of an investment, you cannot fail to see that the plant with which you can pump water with the least fuss, the least trouble and the least stoppage, is certainly to be desired, and although there are lots of things that we want to buy sometimes that we don't have the money to buy, it is worth straining a little point to get these effects in things as important as water works plants.

The question of high and low duty is a vexed one sometimes. Sometimes the low duty engine will pay the best, where fuel is the cheapest; but where the expense of fuel goes up to any great extent, the benefits of expansion ought to be had for the best results in the end, and, as I said before, a high class engine in good hands, although it makes an investment looking large at first, is really the most economical and the most desirable.

That is about all I have made notes of, and I thank you for your attention, gentlemen.

Mr. Decker:—Mr. President, I would like to ask Mr. Hague a question. Do I understand Mr. Hague that he would not recommend a condensing apparatus on an engine of a million gallons capacity? Say an engine of a million gallons pumping to a reservoir with a dynamic pressure of from 60 to 75 pounds, running at a speed of 90 to 100 feet, and with a steam pressure of 75 to 85 pounds—a compound engine. Would it be economy to use an independent condenser on that engine?

Mr. Hague:—In reservoir service, certainly; but my remarks pertained to direct service where you run your engine as the water is demanded, which, as most of

you know, is sometimes at a very slow speed. But for for reservoir service, where you can run at full speed and pump a certain amount of water and then stop, a condenser certainly is to be preferred.

MR. DECKER:—Another question. Suppose you are pumping a lime and alkali water, which produces a heavy and rapid scaling of boilers, would it not be more economical to use a surface condenser? Would not the advantages gained by the purification of that water in the condensation of steam overcome the loss in heat to your feed water, do you think? Would it be economy to trade off the heat imparted to your feed water by exhausting through a heater for the vacuum gained by condensation?

MR. HAGUE:—Well, I would not trade off. I would use the surface condenser and heat the water as well by the exhaust from the feed pump. You see, in almost all these plants there is a steam feed pump. Indeed, an independent feed pump is the best practical thing to use, any way, and there is a great deal of heat comes from an ordinary, direct-acting feed pump, and with an engine of high economy the direct-acting feed pump would heat the water up to a good point, so that, as I said a little while ago, you can get the benefit of a surface condenser, of a high vacuum, and at the same time heat your feed water. When it comes to the question of sacrificing the temperature of the feed water to get a vacuum, I would hesitate very long. At sea they very often cut the vacuum down to 23 inches for the purpose of keeping up the feed water, and the ship makes the best headway. Where you can retain the heat of the feed water, I would say get the highest vacuum you can.

MR. RICHARDS:—How is the strainer made that keeps back the oil?

MR. HAGUE:—It is a very simple vessel. Sometimes they use coke, sometimes straw—just a very plain, ordinary thing. Almost any man, with a little study, can make such a thing. There is a regular article made for that purpose. But it is a very simple arrangement to strain the water.

MR. DUNHAM:—Mr. President, we like sometimes to do things in a quiet way, and where steam is thrown into the atmosphere through a free exhaust it is frequently noisy, and it is always more or less attracting observation. Now, the condenser enables us to avoid that. I would

like to ask Mr. Hague if there is any simple, easy way of taking care of the steam without a condenser, so that it would not be objectionable.

MR. HAGUE:—To stop the noise? No, I don't think there is any way of doing it. I don't know of any way except by a condenser to smother the exhaust steam. If it is a nuisance, of course that may be worth while.

MR. GERECKE:—Mr. President, a word as to the oil being taken out of the surface condenser. This is already provided for by a new apparatus through which the exhaust steam goes before it reaches the surface condenser, I have forgotten the name of this apparatus. It is used on many steamboats, especially on Atlantic steamers. Every bit of oil is taken out of the exhaust steam before it reaches the surface condenser, and in that way all danger of getting oil back into the boiler is entirely done away with. It is highly recommended as being perfectly successful.

Then there is another point about getting rid of the exhaust steam. There are injectors by which they are using the exhaust steam for injecting water into the boiler. The injectors are made in such a way you need not use any high pressure steam or steam direct from the boiler; you use exhaust steam from a high pressure engine and inject the water into the boiler with the exhaust steam. That does away with all noise and all trouble from the exhaust steam after it has left the engine.

MR. DUNHAM:—I would like to know if that can be used with a compound engine?

MR. GERECKE:—I could not tell. Where I saw it it was on a high pressure engine. In the eastern states they are using it quite often now.

MR. DUNHAM:—Would that be used continuously, or only at intervals?

MR. GERECKE:—They use it right along for feeding the boilers.

MR. HAGUE:—I am familiar with what Mr. Gerecke speaks of—the exhaust injector. It does work well, but as he says, it is mostly with high pressure, where the terminal pressure is a little above the atmosphere or about to the atmosphere. But with compound engines, where the expansion goes pretty well below the atmosphere, I think it would be a little doubtful. I never saw it under

those conditions. As to straining the oil from the exhaust, of course that would produce the same effect, and is used quite extensively.

MR. DENMAN:—Mr. Chairman, I am made the vehicle of a pleasant duty; to present in this public manner to the Association the following resolution passed at a meeting of the ladies held this morning:

"We, the ladies and guests of the American Water Works Association, hereby express our pleasure in a vote of thanks to C. E. Burke, Esq., for the courtesy extended to us in showing the sights, manufacturing interests, etc., of Cleveland.

(Signed.)

MISS MINNIE RYLE.
MRS. RICHARD HOLME, Jr.
MRS. A. N. DENMAN,
MRS. B. F. STEPHENS,
MRS. WM. RYLE,
MRS. ALIDA LATTIMORE,
MRS. A. W. MORGAN,
MRS. REUBEN GETZ,
MRS CHAS. HERMANY,
MRS. B. R. MORTON.

On motion of Mr. Diven, the foregoing resolution was ordered spread upon the minutes.

The following paper on "Recent Filtration Practice in India," prepared by Mr. S. Tomlinson, of Bombay, India, was read by the Secretary:

RECENT FILTRATION PRACTICE.

BY S. TOMLINSON, C. E.

To the President and Members of the American Water Works Association:

GENTLEMEN—I do not propose to go beyond the title nor indeed to undertake a description of all recent filtration practice, but it will be desirable to consider the object aimed at in filtering water and the circumstances which make a filter best able to do its work, in order to make use of the descriptions to be given for our own guidance and to enable us to design the filters best adapted to our own particular case.

The object in filtering any water is to remove from it some objectionable matter. The objectionable matters differ very much in character and hence arise the wide differences in the results obtained by filtering water. (The proceedings of the Association for 1883, pp. 18–31 and pp. 49–52, clearly show this.) The matter to be removed may be inorganic, composed of the minutely divided minerals previously eroded from the ground over which the stream has passed; I say, stream, because this

kind of difficulty will not occur in well water, nor will it generally be found an accompaniment of water received from a well-selected watershed of a gravitation supply. The most numerous cases of this will be found in supplies taken from a large stream, generally by pumping The Mississippi and Missouri waters appear to be of this character, (see 1883 proceedings, p. 50,); the River Platte at Buenos Ayres is another example. (See procdgs. Inst. C. Eng., London, Vol. LVII., p. 272.—Higgins on "Experiments in Filtration.") The removal of this material is always found to be difficult. It would seem that this arises from the difficulty of laying down a filtering material which shall possess two qualities: (1.) A permeability sufficient to allow water to pass through at a practical rate at the same time that (2.) the particles forming the filter shall have such fine points and angles as will intercept the remarkably fine particles which discolor the water. (I have had no experience on a large scale with this class of water and therefore do not attempt to prescribe for it.) In clarifying a water rendered very turbid from washing dirty sand, subsidence combined with precipitation by alum or vitriol, was found effective.

The use of precipitants applied to a drinking water supply has many objections and should be very carefully applied in practice. Other waters are deteriorated by vegetable matter, either as peat stain or by the growth of some low form of plant life. The latter appears to be a common case in America (p. 27, 1883 procdgs.) I have noticed it in England also in certain months, and in the Nehar Lake of the Bombay works it is always present, but least in the cool season. It appears that its growth depends upon the temperature of the water. In England it appears and disappears with remarkable quickness with the rise and fall of the temperature in the summer season.

Waters deteriorated in these ways advertise themselves, as it were, so that everybody can see their faults. There remains to be named, deterio ation caused by animal life, which has given rise to bacteriology, a science in its infancy, but which promises to grow into a robust manhood. It seems too early yet to form any judgment likely to be final upon microbes in water. (see Proc. Inst. C. E. London, Vol. 85, Frankland—Purification of water and discussion thereon.)

The points which seem clear are:

(1) Every water as found in nature contains germs, but the numbers vary greatly.

(2) That there are distinct varieties of these.

(3) That because of the continued healthy condition of people drinking water found to contain microbes in abundance, all microbes are not necessarily harmful to life or to health.

(4) That there are, however, true pathogenic or disease producing microbes.

We shall have to await the results of further research before we can with any certainty whether:

(a). A true and desirable object of filtration is to remove all these.

(b). And if so, what material and method is the best considered as a practical question for a Water Supply Engineer dealing with large quantities of water.

(c). Whether filtration by any method will absolutely remove the dangers due to the presence of pathogenic germs.

Very important results depend upon the development of the truth with regard to microbe life in water. Until this development is completed it is satisfactory to find that filtration through sand, as usually practiced, is by no means an ineffectual method of removing these low forms of animal life from water.

These being the typical causes by which water is deteriorated, there remains for determination the best way to remove them. Several mechanical systems are at work, as to which I propose to say nothing, because I have had no practical experience of them. On the general question, however, I should say, that in all water works fittings and designs, simplicity is of the highest importance. Coming then to the generally used sand filters, there can be no doubt that their effective action depends principally upon:

(1) The maintenance of a regular and unbroken depth of sand.

(2) The slow passage of the water through the sand.

The first essential is liable to be vitiated in practice by (a) want of provision for escape of air, (b) the too forcible flow of water from the inlet upon the sand.

As to (a) it frequently happens that water is first admitted on the top of the filter and finds its way through the sand to the outlet*. In so passing down it must displace the air, and this can be seen in some cases bursting its way through the sand and bubbling through the water. These "air eruptions" make small craters through which the water afterwards *runs*, not *filters*, and so the water, instead of passing through all parts of the filter evenly, and requiring some head of water to force its way through, obtains an easier passage at a few places. The same evil is caused by (b) a deficient method for the inflow of water, which displaces the sand and forms an easy passage to the outlet. My experience is that too much care cannot be given to these two points.

The rate of filtration too is admitedly a matter of first importance. The rates given by Mr. Croes for American Filters are far in excess of European practice†. Financial considerations frequently come in the way, but it seems that the best rate for first-class work is from 4 inches to 6 ins. per hour, or 50 gallons to 75 gallons per square foot of filtering area per day of 24 hours. The rate of filtration and the head required will vary according to the condition of the water and the filter surface and to the character of the sand used, and the best practice in any case will be determined after experience only.

Generally I believe it will be found better to clean the surface of the sand rather than to increase the head required, to

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*This is assuming that upward filtration is not practiced. Experience seems to have abolished it from English and even Scotch practice, where it found its birth, but not yet from America, according to Mr. Croes' paper, 1883. A filter cannot be effectually cleansed by reversing the flow of water The best means and cheapest is no doubt to strip the filter of the very thin upper layer, which first receives the water in downward filtration, and which in found to detach from it the greater part of the impurities.

†Liverpool, 4 ins.; Leicester, 6 ins.; Berlin, 4.7 ins.; Stockton and Middleboro 6 ins.; Bradford, 4.

force through the normal quantity of water to above 12 inches. The head is the difference of level of the water over the sand before filtering and in the filtered water channel. This head can be regulated either on the outlet or inlet side, and should be provided for in all works, either in one way or the other, preferably I think, on the outlet side.

The sand to be used will be regulated by local circumstances. The one great essential is that it should be perfectly clean. If any clayey or decomposable matter be admixed the filter will become clogged. Fortunately a suitable sand can generally be found within easy reach of filtration works, or the filtration works can sometimes be put where the sand is. The latter was the case at Bradford, where the sand was obtained by crushing soft sandstone and afterwards washing it.

The town of Bradford, England, is supplied with water under the control of the Corporation. For its trade purposes—*e. g.*, wool washing and dyeing—water of great softness and purity is essential. The former quality is well satisfied by the water flowing from the moors, about 17 miles from the town, which are underlaid by the Millstone Grit Formation, but the water is almost always peat-stained. It was to remove this peat-stain from the water collected in the storage reservoirs, and also the vegetable and mineral matters held in suspension by the water taken into the conduit from the streams met with between the storage reservoir and the town, that the Corporation decided to construct filters at Gilstead, about 5 miles from the town. The site was selected and the designs prepared by Alex. R. Binnie, Esq., M. Inst. C. E., F G. S., the Water Engineer of the Corporation. The works were commenced, departmentally, in April, 1884, and have just been completed. It is outside the scope of this paper to deal in detail with the engineering portion of the undertaking. It will be sufficient to note that the quantity of water to be dealt with is about 6,000,000 gallons per day. The first question to determine was the rate of filtration, and the rate adopted was after careful consideration fixed at 4 inches per hour, and to provide for possible extensions the quantity was taken as being 8,000,000 gallons per day. At the rate determined the quantity per square foot per day is 50 gallons. To filter 8,000,000 gallons there is therefore an area of 160,000 square feet required. But, besides this, provision is to be made for one filter being out of use. The question has then to be determined as to what number of filters will be the most economical to construct and to operate. It is evident that if one basin be provided capable of filtering the whole quantity, the total filtering area will be twice the effective area. On the other hand to subdivide into a large number of basins materially increases the cost of the inlet and outlet works and masonry in proportion to the sand area provided. The configuration of the ground has frequently to be considered as a modifying factor. Mr. Binnie fixed the number at six filters of 33,000 square feet area each. Five being rectangular, 300 ft. by 110 feet, and the sixth an irregular figure to suit the site; total area 198,000 square feet. Five filters are thus able to do the work, leaving one for cleaning and æration when 8,000,000 gallons per day are being filtered and two when 6,000,000 gallons are being filtered.

The three things common to all filtration works are:

1. The Inlet Works.
2. The Outlet Works.
3. The Filter.

1. The Inlet Works.—In this case the general distributing canal is of masonry, 5 ft. by 5 ft., and to each filter a 24 in. pipe is taken, regulated by a sluice in the canal. The water then flows into a cast iron trough running along the end of the filter. The lip of the overflow is planed, as are also the flanges joining the separate 10 feet lengths. The whole length, 100 feet, thus forms a level weir, over which the water to be filtered falls in a very thin sheet, possessing little power to disturb the sand. The flow to the sand is further broken by a water cushion formed by an iron lip on the concrete step; the concrete step being at the level of the sand. This water cushion is only needed at the time of charging, but it is precisely at this time that the sand is disturbed and the filter permanently damaged unless proper precautions are taken to prevent it. In this way the water is admitted with the least possible power to disturb the sand, or to form open passages through it to the drains beneath.

2. The Outlet Works.—The collecting main for the filtered water is of cast iron pipes 30 inches in diameter, with 24 inch branches to each filter, regulated by sluices. A clear water basin is provided at the commencement of the main to the town, holding about 500,000 gallons. There are also alternate arrangements for supplying the town, either independently of the filters or when filtered, without the intervention of the clear water basin. The outlet of each filter is formed by a double well. A rectangular well contains the 24 inch sluice communicating with the 30 inch collecting main, and also two 12 inch sluices, one governing the effluent pipe from the sand washing tank, referred to later, and one governing the cleansing pipe of the filter, by means of which the water in the filter can be drawn off, either partially or entirely, without the aid of the 30 inch outlet main, which may be under pressure passing water from the other filters. The rectangular valve well is separated by its wall from a semi-circular well, into which the main collecting drain from the base of the filter enters. The water in this well has no communication with the water in the filter except through this drain, and hence must be filtered before reaching it. At the bottom of this semi-circular well the 12 inch cleansing and 24 inch outlet mains begin.

It will thus be seen that the sluices governing the inlet to and outlet from the filter provide ample means for increasing or decreasing the head under which the filter is working.

3. The Filter.—The filter itself is built upon the concrete floor, forming the bottom of the basin. This floor rises, from the outlet well just described, 1 ft. 6 in. in the length of the filter, and from center to sides it also rises 1 ft. 6 in. Along the center line the main collecting drain 18 in. square of dry rubble is laid.* From this branches go off at every four feet alternately to right and left. That is, the smaller drains are at every 8 feet.

*It should be noted that the site provided all the materials for the construction of the filter, except Portland Cement, Lia's Lime and Iron.

These small drains travel to the side of the filter, about 45 feet, and there is there inserted into each of them a 3 in. air pipe, the lower part perforated. These air pipes are carried to above the water level in the heart of the wall, so as not to form unsightly objects in front of it. Nothing of them is seen except the perforated cap, and this is flush with the masonry wall of the filter. These pipes are only ⅛ in. thick, and each set weighed 56 lbs. Means are thereby provided for the free escape of any air which may be confined beneath the sand. The spaces between the small side drains which are 6 in. square, are filled with hand packed rubble placed longitudinally with the drains. The lower portion of the basin is filled with rubble about 12 in. deep, the upper surface being horizontal. Above these are ranged 6 in. layers of gravel of gradually decreasing size until the sand is reached. The lower layers were obtained by hand breaking, the sand and three sizes of gravel were from the stone breakers and sand crushing machines, which were provided with suitable revolving screens.

The typical section of the filter is therefore: Sand, 3 feet, 6 in.; 1st, gravel, 6 in.; 2d, gravel, 6 in.; 3d, gravel, 6 in. Rubble as required.

The whole of the sand was carefully washed before being put in place. The basin provides for an ordinary depth of water of 3 feet 6 inches over the sand, but the overflow * is 3 feet higher, to allow of storage of additional water in time of flood. The coping is 2 feet above flood level.

The Filters have just commenced work and it is reported that they have very materially improved the appearance of the water.

There remains only for notice the arrangements for washing the sand which will be removed from the surface at the periodical cleansings. A separate 8 inch pipe is provided from the Distributing Canal to the centre of each of the filters where a sand washing tank is placed, having its lip just above the level of the sand. The tank is rectangular, 10 feet by 6 feet, and about 2 feet deep. The floor is formed of, (1), perforated cast iron plates, on which sand is placed: (2), fine copper wire gauze; (3), perforated elm planking, under the planking is a water space.

This tank is fed from beneath and the water passing up through the dirty sand carries away the dirt, and leaves the clean heavy sand on the floor of the tank. During the washing, the sand is agitated by rakes of a suitable kind. The labor involved in removing and replacing the sand when the washing apparatus is placed in the filter is much less than when it has to be removed from the bed to some other place. The time required to wash the sand, depends, of course, on the quality of the sand and the quantity of dirt in it.

An arrangement is provided by which the dirty water, after leaving the sand washers, is filtered and pumped back again. This will save a considerable quantity of water and prevent the fouling of the stream below. The pump provided is a 6 H. P. Davey Motor, with 3 Throw Pumps and 2 Hopper Boilers, manufactured by Messrs. Hathorn, Davey & Co., of

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*There is only one overflow, and this is in the octagonal distributing well where the water is received from the conduit and passed either to the distribution canal for filtering or direct to the town.

Leeds. The total cost of working this for 12 hours is about 1s, 6d. It is calculated to pump 200,000 gallons in 9 hours, 30 feet high.

The Malabar Hill Reservoir of the Bombay Works was originally designed by the Executive engineer, Rienzi G. Walton, Esq., M. Inst: C. E F. G. S., as an open service basin for the Tulsi Lake Supply. Subsequently, however, it has been converted into a covered basin and divided so as to provide a settling basin, filters and distributing basin for filtered water. The provision of convenient and suitable inlet and outlet arrangements, so as to secure the conditions laid down in the preliminary portion of the paper, is not an easy matter under these circumstances.

The quantity of water passing through is about five million gallons per day. The filters are 4 in number and the areas are 12,454, 13,158. 13,974, and 9,504 square feet respectively. The three largest when available give an active area of 39,576 square feet. To filter the whole supply through this gives a rate of 10 inches per hour or 126 gallons per square foot per day.

1. *Inlet Arrangements.*—From the settling basin a distributing canal goes off, and from it the water is admitted to the filter under an iron penstock working in grooves. The width of the opening is 4 feet, and the depth when fully open, 2 feet. The bottom of the opening is 1 foot 4 inches over the top of the sand. The water being under a head of 2 feet when the settling basin is full, and falling 16 ins. on the sand, displaces it very much. This will shortly be remedied. The water can also be sent direct to the filters without the intervention of the settling basin.

2. *Outlet Arrangements.*—The water passes from the collecting drains of each filter through openings in the floor of the filter, regulated by sluice valves, and can be passed either into a small reservoir below the filters when the distributing basin is not at work or direct into the distributing basin.

3. *The Filter.*—The collecting drains are of brick laid in the haunches of the masonry arches. The remainder of the haunch and a depth of 18 ins. over the arches is filled with gravel. This is overlaid by 9 inches of shells and on these sand 2 feet in depth is placed.

The desposit of the Tulsi water is partly vegetable growth and partly a finely divided red earth, derived from the lake bed, the water when the lake is low having a deep red tinge. Filtration, even at a rate of 10 ins. per hour, greatly improves the water, and if the rate could be lowered would still further improve it

The whole of the works are now covered. It should be noted that this was not primarily done from an Engineers' point of view, but to satisfy the popular opinion that if the works were left uncovered, bones, etc., would be dropped therein by birds on their way from the Parsee Towers of Silence * which adjoin

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*The Parsees, who form a prominent and numerous part of Bombay society, deposit the bodies of their deceased friends within a tower Vultures are always in readiness to remove the fleshy parts. At night the vultures leave the towers.

the Reservoir. The effect of roofing the Filters has, however, very much reduced the growth of vegetable life, which occurred when they were open.

The dirty sand is removed from the bed and washed in tanks placed just outside the filters and at a lower level, so as to obtain a pressure of water sufficient to effect the cleansing. The dirty water is passed off and finds its way into the sea which washes the foot of the hill.

The Bhandarwada Works were designed by C. B. Braham, Esq., M. Inst. C. E., late Deputy Executive Engineer, to supply a storage basin, filters and distributing basin for the water brought from Vehar Lake through a 32 in. main, the quantity being about eight millions of gallons daily. The water contains much flocculent vegetable matter, which gives the water a green color when viewed in bulk; filtration effectually removes this. The deposit on the sand rapidly dries when the water is drawn down for cleaning, and can be peeled off, being quite tough and almost independent of the sand.

The filters are six in number, five being 200x80 ft. each, and the sixth 110x145 ft. The effective area of five of these is 80,000 square feet, and taking the quantity of water at eight millions of gallons per day, the quantity is 100 gallons per square foot per day, or a rate of eight inches per hour. If the filters could be kept clean, this rate would probably satisfactorily cleanse the whole supply, but the vegetable matter deposited on the top of the sand rapidly coheres and forms a covering over the sand, through which the water does not readily penetrate, and which prevents a good rate of filtration, even when the head is increased The filters, therefore, require very frequent cleansings, generally about every tenth day. One day is required for cleaning, and, when practicable, another day is given for aeration. The head required varies from 3 inches when the filter is first started to 15 inches when required to be cleansed.

1. The water from the 32 in. main first passes into a distributing canal of masonry 36x30 in., from which are openings with penstocks 24 in. wide and 12 in. deep, admitting water to each of the filters. The bottom of the penstock opening is 2 ft. above the level of the stand. To break the fall of the water a well or water cushion is built in front of the penstock 4 ft. wide, 20 ft. long and 3 ft. 6 in. deep, the coping of the well being level with the sand. In spite of this provision the water requires to be admitted very slowly until the level of it in the filter is equal to the level in the distributing canal, in which case no fall can take place. This is the only point of difficulty in working the filters.

2. The base of the filter communicates freely with a clear water canal 3 ft. wide and 7 ft. deep, from which there are openings into the distributing basin. These collecting canals and openings are distinct and complete for each filter and do not communicate one with each other. A gauge-board is placed in each, which being level with a similar gauge-board over the sand in the filter, gives at a glance the difference in the level or the head of water under which the filter is working. The inlet sluices to the distributing basin are double, one at the bottom for use when the filter requires to be drawn down, and one 24 in. wide and 12 in. deep for general use is placed with its lip 12 in. above the level of the sand. This provision, together with

the regulating inlet sluices, enables the filter to be regulated as required to meet varying conditions.

3. The filter itself is formed of sand, 2 feet, 6 ins.; gravel, 6 ins.; bricks, 6 ins.; total 3 feet, 6 inches.

The walls are 3 feet 6 inches higher than the sand and the waste weir admits a depth of 3 feet of water over the sand. The upper layer of bricks is placed transversely over the lower ones, which again are so arranged as to form a drain to carry away the filtered water. Air escapes are provided at the Inlet end of the Filter by two 3-inch pipes rising through the filter from the base.

4. The sand required to be cleansed is removed from the filters, and to facilitate this removal a narrow tramway is laid on the top of the masonry walls dividing the filters from each other. The sand washing wells are similar to those at Vehar, to be described lower.

A second main having been laid from Vehar to the Island of Bombay, filters were provided near the Vehar Lake to deal with the water passing through it. The filters are five in number, each being 70 feet from the inlet to outlet and 80 feet wide. Four filters being acting give an area of 22,400 square feet. It was intended that 2,250 000 gallons per day should be passed. This gives 100 gallons per square foot per day, or a rate of 8 inches per hour.

1. The water from the lake first passes from the 24-inch main into a regulating chamber, and thence into a distributing canal 30x30 inches, and is admitted to each filter through an opening 24 inches wide by 18 inches deep, governed by a penstock opening downwards. In front of the inlet there is a water cushion as provided at Bhandarwada, 3 feet wide, 20 feet long and 42 inches deep. The quantity of water passing to the filter being only one-third of that passed through a similar entrance and into a similar cushion, it works better here than there, due care being had in first filling.

2. The collecting canal runs along the opp site end of the filters to the inlet or distributing canal; it is 30 ins. wide and 7 ft. deep. There are divisions opposite the separate filter walls to prevent the filtered water from passing from one filter to another. If this be desired at any time it can be effected by passing the water back through a 12 in. cleansing main used for drawing off the water from the filters, but which, by alternate sluices, can be made to pass water from one filter to another. By these arrangements the collecting canal can be maintained practically at the same height throughout its entire length, keeping the delivery into the city main as far as possible even and regular. The water is delivered from the collecting canal through openings 2 ft. x 2 ft. governed by penstocks opening upwards, the sill of the opening being 12 in. above the level of the sand. This discharges the water into a chamber 3 ft. x 3 ft., which contains an 18 in. branch from the 24 in. city main. In the branch a sluice it placed so that the water can be sent direct to the town when the filter is not at work. By means of these branches the filter can be charged from below after the periodical cleansings; this being done slowly enables the air to escape from the sand without disturbing it.

3. The filter is of the same section and construction as already stated for Bhandarwada Works.

4. *The Sand Washing Tanks.*—Alongside the Distributing Canal and opposite each Inlet to the Filters is a masonry well 12 ft. x 8 ft. for washing the sand. The floor is made of perforated zinc plates, laid on and supported by teak wood planks, perforated with $\frac{3}{16}$ inch holes, $1\frac{1}{4}$ inch centres. These planks are carried on stone blocks 6 inches high, leaving a space beneath, into which the water first flows and then passes up through the sand, being under pressure from a 4-inch branch pipe laid from the main from the Lake just before it enters the filters. The dirty water is drawn off beneath the floor by a 4 inch outlet into a waste channel. During the action of washing, the water rises above a wall of the well and falls into the waste channel. The depth of the well is 2 feet 6 inches to the floor. The sand from a filter can be removed, washed and replaced in 2 days.

In conclusion, I wish to thank Mr. A. R. Binnie, under whom I had the pleasure to act as Resident Engineer on the Gilstead Works; and Mr. Rienzi Walton, under whom I have now the pleasure to serve as Deputy Executive Engineer, Bombay Water Works, for their kind permission to describe the works and for the assistance they have given me in placing drawings at my disposal.

Mr. Decker moved that a vote of thanks be tendered to Mr. Tomlinson for his paper. Seconded and carried.

Mr. W. G. Richards read the following paper:

PRACTICAL RESULTS OF MECHANICAL FILTRATION.

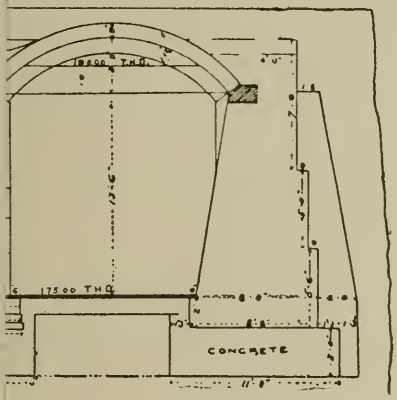
BY W. G. RICHARDS.

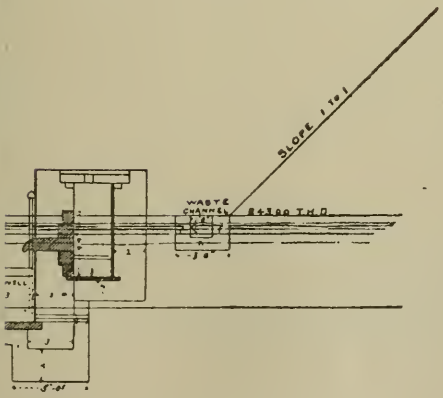
The filter plant at the Atlanta Water Works consists of twelve Hyatt Filters ten feet in diameter, thirteen feet high. The filters are cylindrical, and are placed on end in two rows; the main supply pipe passing between them; the center of the pipe being eight inches below the center of the filters, or about five feet above the pavement of the filter room.

The filters are divided into two compartments, or sections; the lower section being the filter proper; the upper section being used for the purpose of washing the filtering material, which is sand and coke—in the proportion of about three parts sand to one part coke.

The sand used is of a good sharp quartz, and the coke is the ordinary coke that is taken from the smoke box of a locomotive and passed through a sieve of about a quarter inch mesh. The depth of the filter bed is kept at about five feet.

The material of which the filters are constructed is ordinary boiler plate; the lower section $\frac{5}{16}$ inch thick and the upper section $\frac{3}{16}$ inch thick; the heads, or more properly speaking, the bottom, and the partition in which the valves between the upper and lower sections are placed are $\frac{3}{8}$ inch thick.

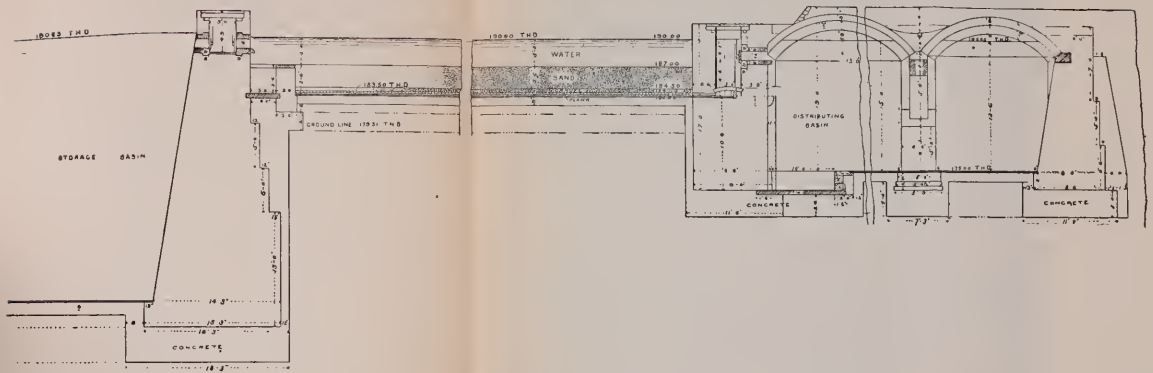




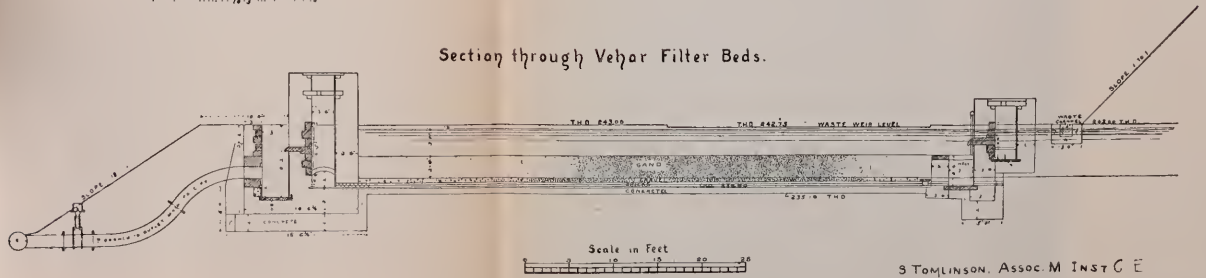
JSON. ASSOC. M INST C E

BOMBAY WATER WORKS.

Section through Bhandarwada Filter Beds.



Section through Vehar Filter Beds.



S TOMLINSON. ASSOC. M INST C E

No doubt a majority of the members of this association are familiar with the operation of the Hyatt Filter; but doubtless there are some of you to whom a description will, at least, be worth listening to. In the case with us the water flows from the impounding reservoir, through the filters, to a clear water basin by gravity, the surface of the water in the reservoir being nineteen feet above the top of the sand and coke in the filters. Within twenty feet of the filters is situated the clear water basin into which the water passes from the filters; the average height of the surface of the water in this reservoir is on a level with the bottom of the filter.

The situation of the impounding reservoir in this instance was rather favorable for the introduction of a filter of this description, the pumps being about 24 feet below the surface of the water. The suction pipe was cut, and a tee inserted diverting the water by an arrangement of valves from its direct passage to the pumps through a twenty-inch pipe, and thence by means of branch pipes six inches in diameter, it is distributed to the various filters. The water in its passage, and before it reaches the filters, passes a twenty inch valve, which is closed enough to somewhat impede the flow, and cause a diversion of a portion of this water through a $\frac{3}{4}$ inch pipe to the bottom of an iron reservoir holding about eight cubic feet of alum in solution. There is another $\frac{3}{4}$ inch pipe passing from this alum tank to the other side of the twenty inch valve where it enters a brass pipe one inch in diameter placed across the twenty inch supply pipe horizontally and vertically; this cross pipe has a number of holes one sixteenth of an inch diameter, through which the solution of alum is discharged into the moving column of water on its way to the filter beds, so that the water reaches the filters impregnated with the coagulant.

After passing through the filter bed the water enters a number of small copper saucers which are attached to the end of pipes, and are filled with copper shot about a tenth of an inch in diameter; the saucers are covered with a piece of sheet copper punctured from the inside with small holes not large enough to allow the shot to pass through. Gate valves are attached to the inlet and outlet pipes, so arranged that the current may be reversed when the sand and coke are being discharged into the upper chambers for washing. In the top head or partition of the filter are seven two inch pipes extending to nearly the bottom of the filter, through which the coke and sand is thrown into the wash chambers; there are other valves arranged around these pipes in the partition to admit the coke and sand to the filter chamber after it has been washed. These valves are opened by an ingenious arrangement of hydraulic heads at the upper end, and held in position, when closed, by springs which are coiled outside the 2-inch pipes. The clear water is discharged through 6-inch pipes into a 30-inch pipe, which conveys it to the clear water basin. The filters are operated from a floor which is within four feet of the upper edge of the filters, and the work is performed by two men, one at a time, day and night.

The subject assigned me on the programme is: "Practical Results of Mechanical Filtration;" but, as I am neither engineer nor scientist, my subject would, perhaps, have been better stated if transposed, being Mechanical Results of Practical Fil-

tration. Our impounding reservoir covers an area of 52 acres, and the banks are just as nature left them, except that about three-fourths of the timber has been cleared off. The washings are for the most part red clay, which is held in suspension to the extent that the water is never clear; its condition being muddy or very muddy. On the water shed, which covers an area of at least five square miles, are numerous dwellings, whose washings, notwithstanding they are watched closely by the sanitary force under the direction of the Board of Health, find their way into the reservoir, so that the water before filtering is unfit for anything except sanitary uses; it very rarely being sufficiently clear for bathing or laundry uses. After passing into the clear water basin small objects are plainly seen through it at a depth of twenty feet, and the bottom is plainly seen by moonlight. I quote from the report of our Board of Health:

"The sanguine expectations have been fully realized. The clear, sparkling water which has recently supplanted the muddy liquid to which we had become accustomed attests the completeness and value of the work done by the Newark Company. The accompanying analysis, made by Mr. Jno. M. McCandless, shows the quality of the water, now received, after passing through the filters to be unexceptionable. Grains per U. S. gallon, total solids 3.60, sodium chloride 0.76, oxygen absorbed 0.03. Parts per million, free ammonia 0.08, albumenoid ammonia 0.03. It is important to understand that the large proportion of free ammonia detected in the specimen is due to the fact that a small quantity of alum is used in this system of filtration as a coagulant. Ammonium is frequently employed in the manufacture of alum as a substitute for potassium; hence it becomes one of the bases of this salt, and ammonia is liberated when the alum, the sulphate of alumiuum and ammonium, is decomposed in the Wanklyn process of analysis."*

I personally know but little of the scientific results. This I know; that it was muddy and now it is clear. The capacity is three million gallons in 24 hours. The cost of 12 filters, including the house over them, was $56,200.00. Filters and clear water basin was $55,000.00, house over filters $1,200.00. We are now filtering an average of about two million gallons per day at a cost of $10.50, $8.00 for alum, and $2.50 for labor. The quantity of alum required is contingent upon the quality of the water, and as the water contains more mud during the season of heavy rains, we have used perhaps the maximum, as the filters have only been in use since last November. I do not anticipate that the average for a year will be as much as the filter company allows, which is one grain to the gallon. There is but a small percentage of waste of sand and coke in washing, and of this I have made no estimate. I have found but one class of persons, and not many of those, who object to the Hyatt Filters; these

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*Note.—Since the Meeting Mr. Richards furnishes the following analyses of the water before filtering:

Sample No. 1—procured after heavy rains: Grains per U. S. Gallon. Total solids 8.03 Sodium Chloride 0.75. Parts per million: Free Ammonia 0.05, Albuminoid Ammonia 0.15.

Sample No 2—procured after several weeks drouth: Grains per U. S. Gallon. Total solids 4.10. Sodium Chloride 0.68. Parts per Million: Free Ammonia 0.02, Albuminoid Ammonia 0.10.

are among the users of steam, who complain that the alum leaves a deposit in the boilers; but they found fault when they were compelled to take out the hand hole plates once a week and even oftener, if possible to do so, to remove the mud, and now they find fault if they cannot run always without any trouble to themselves.

Our engineer at the works has found no fault, and, on the contrary, is much pleased with the water so far. As a matter of course if there be alum or any other substance in the water, it would necessarily be deposited in a boiler. I am not prepared to say that there is not a small per centage of the alum left in the water after it has passed through the filter beds; but as the alum is used to coagulate the mud, the greater portion will be found with the mud coagulated.

If the water flowing from the filters to the basin were not clear then we might expect with the coloring matter a percentage of alum.

At present there has but one analysis been made, and that by a local chemist; but it is the intention of our Board of Water Commissioners to have an analysis made by three different chemists residing outside of our State. Had these analyses been made prior to this meeting this paper would doubtless have been more interesting and satisfactory.

MR. PRESIDENT:—This a matter of a great deal of interest. I presume you would like to ask Mr. Richards questions upon it.

A MEMBER:—I would ask Mr. Richards whether the full head of nineteen feet is used to force the water through the filter?

MR. RICHARDS:—Yes, sir, the full head of the water in the reservoir.

MR. FULLER:—I would ask Mr. Richards in regard to the color of the water after it has been through the filter, whether it still retains some of its color, or whether it is nearly colorless?

MR. RICHARDS:—The water is perfectly clear after it passes through the filters.

MR. STEPHENS:—This experiment has been in operation, if I understood correctly, from November last —about six months?

MR. RICHARDS:—Yes.

MR. STEPHENS:—Then the question naturally would follow whether the materials held in suspension are greater in summer than in winter. If so, the experiment would be more satisfactory if we had it for the full year?

MR. MAXWELL:—I would ask Mr. Richards if he would not think that during the summer and fall, or during the decay of vegetation, there would be a great deal more vegetable matter to take care of than in winter. It would depend somewhat on the nature of the watershed, of course?

MR. RICHARDS:—I should think probably there would be, but as we have not yet had an opportunity of running it in the summer, I could not definitely answer that question.

MR. MAXWELL:—Does your impounding reservoir collect moss and vegetable growth on the surface during the summer?

MR. RICHARDS:—No, nothing of that kind. The impounding reservoir, I forgot to mention, covers fifty-two acres.

MR. BILLINGS:—I ask Mr. Richards how much water it takes to cleanse the filter, per million gallons filtered.

MR. RICHARDS:—To that question I can make no positive answer, but as we use the pond water to wash the sand, we pay but very little attention to it. We do not use the clear water to wash the sand, or the sand and coke.

MR. HOLME:—What is the capacity of the clear water reservoir—that is, the reservoir which holds the water after it passes through the filters.

MR. RICHARDS:—The clear water reservoir holds 360,000 gallons.

MR. HOLME:—Is it lined with stone?

MR. RICHARDS:—Lined with hydraulic cement. It is built of brick.

MR. HOLME:—Have you ever noticed any growth of any kind of vegetable matter in that reservoir?

MR. RICHARDS:—So far we have noticed nothing in there. We have not thoroughly cleaned it, either, since we began using the filters.

THE PRESIDENT:—Do you have any ice in your basins in winter?

MR. RICHARDS:—No, sir; we have very little ice around there; not enough to interfere with a structure of

that kind. In the clear water basin I never expect to see ice; the water would not remain quiet long enough for ice to form to any extent. The climate is mild.

MR. DUNHAM:—I would like to inquire whether the cost of power to operate the filters is included in the estimate given?

MR. RICHARDS:—There is no power expended. It is done by gravity. There is nineteen feet head.

MR. DUNHAM:—Is the water pumped after that?

MR. RICHARDS:—Of course.

MR. DUNHAM:—Have you made an estimate of that?

MR. RICHARDS:—No, sir.

MR. JUDSON:—Is the analysis you gave an analysis after the water passed through the filters?

MR. RICHARDS:—After the water passed through.

MR. JUDSON:—I would ask Mr. Richards another question, and that is about those copper balls, or that copper arrangement about which he spoke. I did not understand the arrangement of that.

MR. RICHARDS:—The copper discs are placed there to prevent any of the filtering material from passing out of the filter.

MR. JUDSON:—A sort of valve arrangement?

MR. RICHARDS:—No, sir; they are copper discs, in which is placed a small quantity of shot. Fine holes are punctured through a sheet of copper, which is put over them on the under side, so as to show the burr on the outside. None of the sand or coke that is in the filter passes out through them.

THE PRESIDENT:—The next in regular order would be a paper by Mr. Harrison, on the "Use of Liquid and Gaseous Fuels." Mr. Harrison is not present with us. I think Mr. Gerecke has made some experiments in Chicago or elsewhese on the use of liquid fuels, and perhaps he might at this time give us a little information in regard to what he has done. We found the information Mr. Whitelaw gave us last evening to be very interesting, and valuable in a financial way to many of us.

MR. GERECKE:—When I left Chicago last Monday I had to leave so suddenly that I was not prepared to say anything upon this subject. I was not then a member of the Association and I came here at the request of our Commissioner of Public Works. What I say to you now is only from memory. A few days ago I had to pass on the bills for our experiments made in burning oils. On the Fullerton Avenue conduit we have a double engine pumping water from the Lake into the north arm of the river, for flushing the river, to get rid of the sewage, which we pump out at the southern arm of the river. We used coal there for six months and measured and weighed everything; took also an account of the number of hours the engines were running. Last winter we used oil; it was used at the wish of a man who had a patent burner. He furnished the oil for a certain price, and the coal costing us a certain price, we made a comparison. We found that for the six months the city would have to pay $885 more for the oil than for the coal. Reducing it to hours this made 22 cents an hour more for oil than for coal. But as the city did not intend to go experimenting, the man who presented us with the burner allowed us $100 or $150 on his bill, so that the city would not lose anything. It would probably have been cheaper to have burned oil, but as we have a certain number of men engaged always in these works, no reduction was made in the number of men, and the expense of the whole plant was the same for burning oil as for burning coal. Of course we could get rid of a good deal of labor by the use of oil. No attention is required except to keep the tank full. There is no cartage of ashes, or anything of that kind.

A MEMBER:—What were your prices?

MR. GERECKE:—I can not remember.

MR. GARDNER:—How long did your experiments continue?

MR. GERECKE:—Six months.

MR. GARDNER:—What difference did you find in wear and tear on the brick work, the effect on your boilers, etc.?

MR. GERECKE:—It did not make any difference whatever. I believe that oil would be less injurious, because there is no baking of cinders and no raking of ashes, etc., required. There was less loss and a cleaner job with the oil than with coal.

MR. DIVEN:—And a uniform pressure?

MR. GERECKE:—Oh yes, always a uniform pressure.

MR. DIVEN:—And you had no accidents?

MR. GERECKE:—No accidents whatever.

MR. TROY:—How many gallons of oil compared to a ton of coal?

MR. GERECKE:—Even that I could not answer. At least, I would not like to answer it from memory.

MR. TROY:—Like brother Gardner, I am in a country where we have to pay a high price for fuel, and we are a little interested in the oil question.

THE PRESIDENT:—Mr. Gerecke, will you kindly put some of those statistics together, so that they may be embodied in the report of your remarks this morning?

MR. GERECKE:—Certainly. I will send them to you from Chicago.*

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*NOTE:—Since the meeting, Mr Gerecke furnishes the following:

Correct statement of the test between coal and oil, as made at our Fullerton Avenue conduit in 1886 and 1887, each test taking 6 months.

On July 26th, 1887, a contract was made for a lot of fuel-oil to be used with a certain burner, under the condition that 2,250 tons of oil must be equal to 4,000 tons of coal, which would evaporate 9 pounds of water with one pound of coal.

The price for oil to be .....$5.50 per ton,
While the coal would be .....$3 14 per ton.

From September 26th, 1886, to February, 1887, were used 1502.4 tons of coal in 4,172 hours and 5 minutes to pump 3,808,675,660 gallons of water.

The cost of coal was .....$4,717 53.
Consumption of coal, per hour..... 720 21 pounds.
Water pumped, per hour.....912,895 gallons.
Water pumped with one pound coal..... 1267.5 gallons.
Cost of coal per hour..... $1.1307.

From September, 1887, to February, 1888, were used 6,933 barrels and 33¼ gallons of fuel oil in 4 184 hours 30 minutes, to pump 3,863,823,550 gallons of water.

The cost of the oil was ..... $5,686.01.
Consumption of oil per hour .....494.122 pounds.
Water pumped per hour.....923,365 gallons.
Water pumped with one pound of oil .....1868.69 gallons.
Cost of oil per hour ..... $1.3585.
Difference between oil and coal per hour.....22.78 cents.

The amount of water pumped by coal, to the amount pumped by oil = 1 : 1.4743

Price of coal per ton to price of oil = 1 : 1.7516.

Price paid for oil more than for coal.....$968 48.
Reduced to the same time as using coal.....$889.34.

As the above was done for an experiment the bill presented for payment for oil was 6,933 33¼-42 bbls. of oil at 67c. per bbl., $4,645 64, which was paid by the city.

While at Cleveland, I visited the Otis Steel plant, where oil is used under the boilers for generating steam, and I gathered this information:

Cost of oil per bbl., 55 cents, at 42 gallons per bbl
Stack coal per ton, $1 25.

Evaporation of water by coal per pound, 6½ to 8 pounds of water, against 14 to 15 pounds of water per pound of oil.

The use of oil will be by far cheaper there than coal on account of saving of

THE PRESIDENT:—We have heard some reports as to the destructive action of the use of oil on boilers. Can you tell us whether that was probably due to a faulty arrangement of the burners?

MR. GERECKE:—Really, Mr. President, I have been in Chicago only two months and a half and could not answer that question.

MR. BENZENBERG:—Are there any offensive fumes or odors noticable from the oil which would make it offensive to the surrounding territory, or to people doing business in the vicinity, or any offensive odor from the crude oil in the tank?

MR. GERECKE:—You could smell it of course, when the oil was burning, in the house, but outside there was no smoke and nothing offensive.

MR. PRIDDY:—They are using crude oil with us considerably, in the mines, now. They put tanks upon the hills above and are beginning to use it quite extensively, and expect to this summer. The weather is so severe that the oil congeals in the pipes. We have had one accident, resulting in the burning down of a large tank. That I attribute more to the carelessness of the engineer than to anything else. But where they have used it it has seemed to be pretty satisfactory. I have not yet looked into it personally to any great extent.

MR. DUNHAM:—I would inquire of Mr. Gerecke whether they had a large quantity of the oil stored outside of the building?

MR. GERECKE:—No, they got the oil by the car-load and when that was consumed they got more. They had it near by, but I do not know where they got it from.

MR. STEPHENS:—I would ask Mr. Gerecke if he was favorably impressed with the use of oil over the use of coal, and if, at the same expense, he would favor the one over the other?

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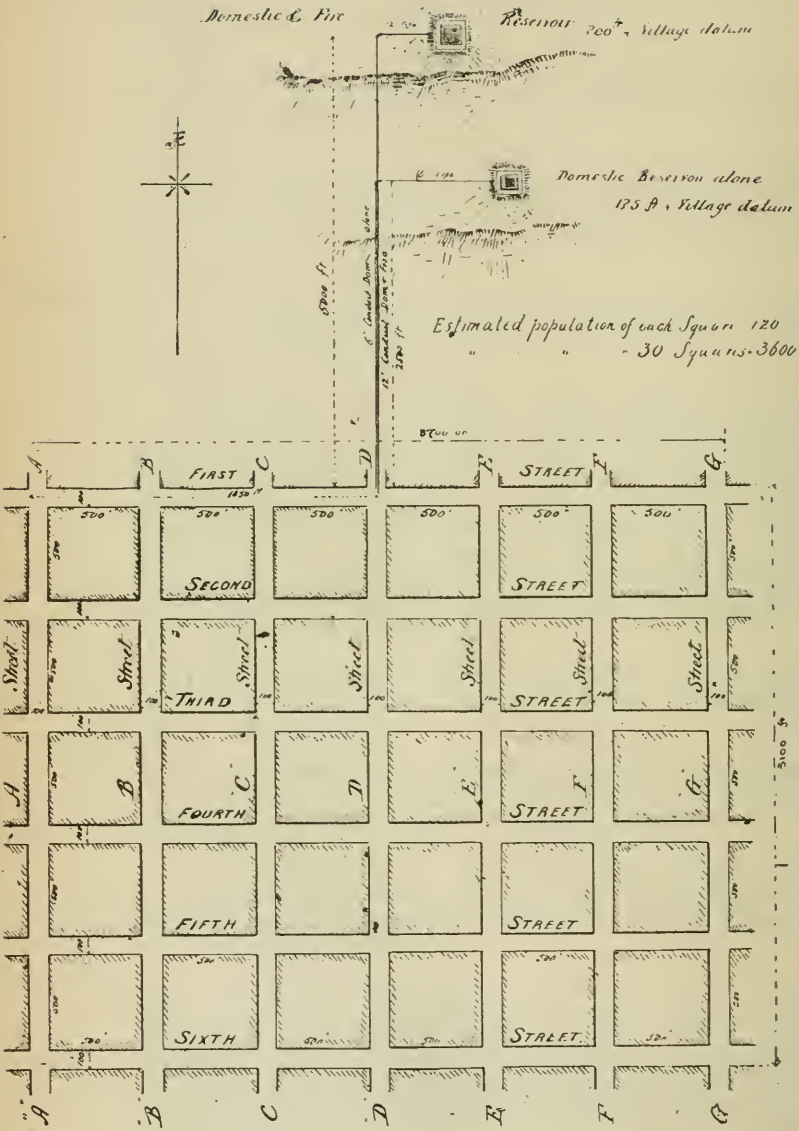
labor; one man only is present in the boiler-house, where a number of boilers are used; while we here in Chicago kept all hands, which were employed when using coal.

The oil is supplied to the burners by two small duplex steam pumps, which draw the oil from a large tank some distance from the shop, so that in case of a fire no danger can arise from a large storage of oil in the building.

The tank is located quite low, while the car-tracks are elevated so that the oil can flow from the oil tank on the car to the storage tank below, and all necessary care is taken to save labor.


Domestic & Fire
Reservoir 200ft. Village datum
Domestic Reservoir alone
175 ft. Village datum
Estimated population of each Square 120
" " " 30 Squares 3600
FIRST
STREET
SECOND
THIRD
FOURTH
FIFTH
SIXTH
A
B
C
D
E
F
G

MR. GERECKE:—Really, I have had too little time to devote to the subject to be able to answer that question.

MR. STEPHENS:—That question is a very important one. I am about to apply it, in any event, to a boiler I have. I was privileged to visit the Standard Oil Works; they have it in operation and they keep it very secret, but what I saw of it impressed me favorably, so much so that I intend to try it. I do not know whether it is a fact or not, but it was given to me that this new "Chicago Pipe Line" that they anticipate building from Chicago to New York, is for the sole purpose of conveying what they call Lima oil to New York for that very purpose.

Mr. J. Nelson Tubbs, of Rochester, read the following paper:

SUGGESTIONS AS TO METHODS, FOR AN APPROXIMATE DETERMINATION OF THE

YEARLY RENTAL VALUE OF FIRE HYDRANTS,

AS CONNECTED WITH ANY SYSTEM OF WATER WORKS.

BY J. NELSON TUBBS, C. E.

The popular notion among both engineers and laymen in relation to this subject seems to be, that the fair yearly rental value of a fire hydrant as connected with a particular System of Water Works, is an indeterminate quantity. The great range of prices which obtains in the various towns and cities of the country, varying as it does from $15 to $125, is probably the result of this popular belief.

After considerable reflection, I am clearly of the opinion that this popular conception is entirely inaccurate. This remark I regard as especially true in relation to all water works plants which have been intelligently constructed with a due regard to the relative requirements for domestic and fire uses.

Preliminary to the discussion of the proposed methods of determination, it may be premised, that this yearly rental value will vary with each plant and will also slightly vary with each series of years of greater or less length, dependent upon improvements and extensions made necessary by increased consumption of water, and the growth of business interests to be supplied and protected.

The principal elements which enter into the determination of this question of values are as follows:

(1) A knowledge of the relations which exist between the maximum amount of water provided, under the plan of construction, for fire purposes, and the maximum amount provided for all other uses at the same moment. This determination of relations to be made not only as to the supply through the conduit, but also as to the distribution pipes through each street.

(2) A knowledge of the relative amount of power required to furnish the maximum amounts of water for fire purposes and domestic uses, in the case of a pumping system, or of head in case of a gravity supply.

(3) A knowledge, in case a reservoir or stand pipe is used, of the increase in capacity required, because of the fire protection.

(4) A knowledge of the number, size and character of the fire hydrants and their branches, and the specials and gates used in the fire provision.

(5) A knowledge of the annual cost of superintendence of and repairs of the fire hydrants.

The inte ligent Water Works Engineer, when called upon to design a Water Works System, after having determined the *source* of supply, proceeds to inaugurate a careful inquiry into the question of maximum *volume* of supply required. This latter determination, in view of the almost phenomenal rapidity in growth of many American towns, is very largely problematical and its value will largely depend upon the experience, intelligence and sound judgment of the Engineer; and whether the determination proves a correct one or not, it must be made.

The usual method is, by careful inquiry, and examination of the location and its natural advantages for business expansion, to arrive at a judgment of the probable eventual population and the character of the business enterprises to be most largely instrumental in the growth of the town in question.

When the probable maximum population at the end of 30 to 50 years is settled upon, it is further assumed that a domestic supply of from 60 to 100 gallons per capita per day is a fair and conservative provision, and the total daily supply is then for convenience stated in gallons per minute

It is also probably safe to assume that one half of said daily consumption will occur during eight hours. The whole system of pipeage must be adjusted to this maximum rate of domestic consumption.

The next subject of inquiry is the maximum quantity of water per minute which must be supplied for fire protection, and under what head.

To properly settle this question, a familiar knowledge of the character, number and situation of the manufacturing and other industries in the town is required, as on these depend the number, volume and power of fire streams required for protection.

Having settled upon the maximum number and character of the fire streams fairly required at any one time in any special locality, and the resulting number of gallons of water per minute which will thus be used, this number of gallons per minute added to the maximum number of gallons per minute required for domestic use during the 8 hours of supposed greatest consumption, will constitute a fair determination of the maximum number of gallons per minute which must be supplied through the conduit. A further determination must also be made of the probable population and resulting domestic consumption in the various squares and main avenues of the town. This amount added to the required fire protection consumption as previously determined, will also determine the size of the several distributing mains.

The foregoing data being at hand, let the sum of the following items represent the increased cost of the plant, its maintenance and operation because of the provision for fire protection:

(a) The excess in cost of conduit because of the necessity of seeking more distant sources of supply at greater elevations to make the fire service effective.

(b) The excess in cost of conduit, to include fire provision, from the point where a collecting reservoir might be located if a domestic supply only was desired.

(c) The excess in cost of the stand-pipe or reservoir because of the fire provision.

(d) The excess in cost of the distribution in the town itself because of the fire provision.

(e) The excess in cost of the specials used in the mains for hydrant branch connections over the same length of straight pipe, also including increased cost of setting and jointing same.

(f) The whole cost of the hydrant branches and laying same.

(g) The excess in cost of all gates and their setting, in consequence of the increased size of the mains for the fire provision

(h) The cost of all fire hydrants and their setting.

(i) The cost of the annual repairs of the fire hydrants capitalized at 5 per cent.

(j) Two per cent. of the cost of the fire provision as determined by the summation of items (a) to (h) inclusive, to cover cost of care and management of the fire plant and said 2 per cent. capitalized at 5 per cent.

(k) A sum, the accumulated interest of which, at 5 per cent. will produce the cost of the fire provision in, say 35 years, thus providing for its renewal at the end of that period.

(l) The excess in cost in case of a pumping plant, should be included in the items (a) to (h) inclusive, and the yearly excess in cost of operation should be capitalized at 5 per cent

The annual interest on the gross sum of these several items, calculated at such a rate as capitalists are willing to receive for money loaned on good water works securities in the particular locality in question, divided by the number of hydrants in use, may be said to approximately represent the yearly rental value of each of said hydrants.

When thus determined for a system of water works intelligently designed, the yearly rental value of a fire hydrant will change very slightly, so long as the domestic consumption, including waste, does not exceed the amount contemplated by the original plan of construction.

It is a fact, much to be regretted however, that very many existing systems of water supply have been designed by persons totally incompetent for such a duty, and many have been constructed on too small a pattern either because of a lack of means or the stupidity of the local management.

In such cases, the works when first constructed and before the domestic consumption has become large, may and in most cases do furnish water for fire protection in sufficient quantity and under a sufficient head for all practical purposes, but as the

domestic use, with its concomitant waste increases, the volume and head for fire streams diminishes year by year, until the only value the system has for the latter purpose, is the possible furnishing of sufficient quantities of water to steam fire engines at convenient points for use.

In cases of this kind, a yearly determination of values should be made and the methods modified to the following extent:

Instead of seeking to determine the ultimate domestic consumption, the actual rate of such consumption at the date of the examination may be used until such time as the domestic uses have absorbed so much of the volume and head of water as to render necessary the intervention of steam fire engines and other appliances to supplement the volume, power and effectiveness of the streams at the hydrants, when some other method of determination will have to be adopted, the water works having then assumed a value for the extinquishment of fires but little in excess of the old street fire cisterns or reservoirs.

When the works have reached this condition, there should arise but little controversy in relation to values, and a determined effort should be made for a reconstruction of the system under the advice of an engineer of judgment and experience.

One other modification of conditions may possibly be encountered in the experience of the engineer, and that is where, for some cause, the element of sufficient *head* for effective, modern fire streams has been deliberately neglected, but where an adequate *volume* for that purpose has been provided at each hydrant.

The writer can perceive no reason why the method of determination of the rental value hereinbefore indicated, may not be applied in such a case.

If in the exercise of a wise discretion, the engineer shall conclude that the mere furnishing of an abundant volume of water at each hydrant, leaving the head to be supplemented by other appliances, shall prove of sufficient value to compensate for the increased cost of the works because thereof, there can certainly be no good reason adduced to prevent the application of the foregoing methods for determining values.

In such a case we are justified in the assumption, that the supplementing of the head at the hydrants by other appliances, is cheaper than that of providing the head in the original plan of construction.

The writer has had occasion to use the foregoing described methods of determination in the settlement of a controversy between a water works company and the citizens of a flourishing manufacturing village in the State of New York, in which the yearly rental paid for each fire hydrant had previously been $50, but which by this method of determination was reduced to $34.50.

The determination was finally accepted by both parties as a satisfactory solution to the problem of hydrant rental values.

This method had been applied and accepted in the granting of water works franchises in other towns where the plans had been fully settled, also in the determination in my own city of the allowance which should be made to the water works fund for public uses of water.

The method thus briefly stated is respectfully submitted for the consideration and criticism of the members of the Association.

That the foregoing method may be more readily followed and understood, I append the following illustration of its application to an assumed gravity supply, the case being purely an ideal one.

ILLUSTRATION.

Assume a village situated on practically level ground, with 7 streets, each 100 feet wide, running north and south and designated respectively, commencing with the most westerly, as A, B, C, D, E, F, and G Streets. Also 6 streets 100 feet wide running east and west and designated respectively, commencing with the most northerly, as First, Second, Third, Fourth, Fifth, and Sixth Streets, as indicated in the accompanying sketch. These streets divide the village into 30 squares, the sides of each being 500 feet long.

It is further assumed that each square has, or will have, a population of 120, making a present or eventual total population of 3600.

It is also assumed that at a distance of 5000 feet north of the north line of the village, a minimum supply of water equal to 375 gallons per minute may be collected directly into a reservoir at an elevation of 200 feet above the level of the town. Also that the same amount of water may be collected directly into a reservoir 125 feet high at a point 2500 feet north of the north line of the village, or midway between the town and the reservoir as at first assumed

Under these conditions what would be the fair yearly rental value of each two-way fire hydrant?

DETERMINATION.

3600 inhabitants requiring, including all uses, an average of..... 100 gallons each per day = 360,000 gallons per day, or at the rate of 250 gallons per minute.

Estimate ½ of this used in 8 hours, or at the rate of..... 375 gallons per minute.

Estimate a provision of 6 fire streams at 150 gallons each, equal to..... 900 gallons per minute.

Making the maximum estimated requirements.....1275 gallons per minute.

The first assumed reservoir has an elevation of 200 feet plus the village, equal to a static pressure of 86.6 pounds per square inch.

To deliver at the north line of the village (a distance from the reservoir of 5000 feet), 1275 gallons per minute through a 12 inch main, involves a friction loss of about 10 lbs per square inch, which deducted from the pressure 86.6 pounds due to the head of the reservoir, leaves a working pressure at the hydrants at the intersection of the conduit with First Street of 76.6 lbs. per square inch.

As the longest line of rubber 2½ inch hose required to be used at this point (with 1⅛ inch nozzle) need not exceed 300 feet, the friction loss in the hose would be about 29 lbs., which de-

ducted from 76 lbs. would leave an effective pressure at the nozzle of say 47 lbs. which would produce streams reaching about 120 feet horizontal and a vertical height of 90 feet.

Such streams would be regarded as sufficient for a town of the population assumed, and hence the size of the conduit may be fixed at 12 inches diameter.

The next questions to be determined are, whether a reservoir placed at an elevation of 125 feet would be high enough for domestic use in case the fire provision is abandoned, and if so, what should be the size of the conduit?

The second reservoir is assumed to be placed at an elevation of 125 feet plus the village datum, equal to a static pressure of 54 lbs. per square inch.

The friction loss in a 6 inch pipe 2500 feet long discharging at the rate of 375 gallons per minute is about 14 lbs., which deducted from 54 lbs. due to the elevation of the reservoir would leave an effective pressure at First Street of 40 lbs., equal to 92 feet head, which would carry the water to the upper stories of all buildings, if provided with service pipes of reasonable size, and the conduit for a domestic supply may therefore be fixed at 6 inches diameter.

The excess in cost because of obtaining sufficient head for the fire service may be stated as follows, and designated as item (a).

2,500 lin. feet 12 in. pipe = 94 tons at $34 delivered..	$3,196
2,500 lin. feet trenching for and laying 12 in. pipe and backfilling, at 36 cents	900
Amount of item (a)	$4,096

The excess is cost because of increased size of the conduit for the fire service from the second or lower reservoir to the town, may be stated as follows, and designated as item (b):

Difference in weight of 12 in. and 6 in. pipe 2500 ft. long = 57 tons at $34	$1,938
Difference in cost of laying 12 in. and 6 in. pipe 2500 ft. long = 2500 ft. = 8 per cent	200
Amount of item (b)	$2,138

The next question to be considered, is to what extent the size and cost of the reservoir is to be affected by the addition of the fire provision.

In the case assumed, the minimum flow of the collected water is placed at 375 gallons per minute, while the average requirement for the whole 24 hours is at the rate of 250 gallons per minute. It follows that for the domestic supply only, a very small and comparatively cheap reservoir may be designed and safely employed, say with a capacity of 100,000 gallons or less.

The fire provision, must, however, be provided from stored water, and the minimum amount thus stored must equal 900 gallons per minute during the continuance of a fire.

In a manufacturing town a single fire may require fire streams for a period of at least four hours, and it is not unusual that three such fires should occur within a period of 24 hours. This would require a storage as follows: 900 gallons per minute

for 12 hours or 720 minutes equals 680,000, say 700,000 gallons, to which add 100,000 gallons for domestic storage, and we reach the conclusion that we require a reservoir of a storage capacity of 800,000 gallons when we include the fire provision, as against one of 100,000 gallons for the domestic system alone.

The determination of the difference in cost of the two reservoirs is not difficult, and therefore for our present purpose we will assume the amount of this difference in cost, and designate the same as item (c).

Excess in cost of Reservoir because of fire provision (Item c)..$3,500

We will now proceed to the determination of the increased size and consequent cost of the pipe distribution because of the fire provision; and to illustrate will take the case of the main in First Street, or the most northerly street in the village, and which is 3700 feet long and intersects the conduit at "D" Street.

At the northwest corner of the village at the West end of First Street, and at a distance of 1850 feet from the intersection with the conduit at "D" Street, it is required to furnish as follows:

6 fire streams each discharging 150 gals. per minute =	900 gals. per min.
A domestic supply to 300 people = 30 gals. per minute	30 gals. per min.
Total maximum requirement at that point	930 gals. per min.

The friction loss in a 10 inch pipe 1850 feet long under these conditions is about $5\frac{2}{10}$ pounds, which will give practically the same character of fire streams as at corner of "D" Street, where the 12 inch conduit first reaches the North line of the town, especially so in case any less than 6 streams should be used at once.

By a similar calculation we might determine the size of main required for each of the two systems.

We will assume for the sake of brevity that this has been done with the following results:

SIZES OF MAINS REQUIRED FOR THE SYSTEM INCLUDING THE FIRE PROVISION.

First and "D" Streets.	10 in. diameter.
Sixth, A, and G Streets.	8 " "
Second, Third, Fourth, Fifth, and B, C, E, and F Streets	6 " "

SIZES OF MAINS REQUIRED FOR THE DOMESTIC SUPPLY ALONE.

Second, Fourth, Sixth, and "D" Streets	6 in. diameter.
First, Third, Fifth, A, B, C, E, F and G Streets	4 " "

On making the necessary combinations, we find that the distribution which provides a fire protection will require a weight of straight pipe 236 net tons in excess of the domestic system, and about 6000 pounds of special castings.

A detailed calculation will also show that the laying, jointing, &c., of the first system will cost about $900 in excess of the second.

The following statement includes these several items and indicates the excess in cost of the village distribution because of the fire provision, and may be designated as Item (d).

ESTIMATE.

236 net tons straight pipe at $34	$8 024
6000 lbs. specials (estimated) at 3 cents	180
Excess in cost of laying pipe	900
Amount of Item (d)	$9,104

The assumption is made that the town in question will require 50 fire hydrants, and Item (e) will represent the excess in cost of hydrant branch specials and cost of jointing, &c., over the same length of straight pipe.

ESTIMATE.

10,760 lbs. specials for hydrant branches, at 3 cents	$321 00
Extra cost of setting, jointing, &c., over straight pipe	100.00
Amount	$421.00

DEDUCT.

4000 lbs. straight pipe saved, at $1\frac{7}{10}$ cts	$ 68 00
Amount of Item (e)	$353.00

Item (f) includes whole cost of hydrant branches and laying same.

10 net tons straight pipe at $34	$340.00
1000 lin. ft trenching and laying at 26 cents	260.00
Amount of Item (f)	$600.00

Item (g) embraces the increased cost of valves required in consequence of the increase in the size of the distribution mains required for the fire provision. As these can easily be exactly determined, I simply assume an amount for my purpose of illustration.

Excess in cost of gates and setting, Item (g) $500.00

Item (h) includes the cost of all fire hydrants and setting.

ESTIMATE.

50 two-way fire hydrants at $30	$1,500.00
50 setting fire hydrants at $4	200.00
Amount of Item (h)	$1, 700.00

SUMMATION OF PRECEDING ITEMS COMPRISING COST OF FIRE PROVISION.

Item (a)	$4,096 00
Item (b)	2,138 00
Item (c)	3,500 00
Item (d)	9,104 00
Item (e)	353 00
Item (f)	600 00
Item (g)	500 00
Item (h)	1,700 00
Cost of the fire provision	$21,991 00

Item (i) is the capitalization of the yearly cost of repairs to fire hydrants as follows: 50 hydrants at $3=$150÷5 cents=..... 3,000 00

Item (j) is the capitalization of the yearly cost of care and management of the fire plant, as follows: The cost of plant=$21 991+2 per cent.=$$439.82÷5 cents..... 8,796 00

Item (k) is a sum, the accumulated interest of which, when compounded at 4 per cent. will in 35 years amount to the cost of the fire provision plant and also repay the original sum at the end of the period, as follows:..... .....

Formula $S = \frac{1}{1.04^n - 1} + P$. In which S= sum which will at the end of 35 years at 4 per cent. produce (S+P).

P=original cost of fire plant,

n =number of years in which plant is to be renewed,

This formula becomes $S = \frac{1}{1.04^{35} - 1} + \$21{,}991$..... 7,465 00

Total investment required to construct, maintain, manage and renew the fire provision.....$41,252 00

As water works bonds can readily be sold at 3½ to 5 per cent, using the larger rate we have $41,252+5 per cent =$2,062.60 yearly interest on same, which must be paid from fire hydrant rental.

$2,062.60÷50 hydrants equals $41.25 per year as the *rental value of each hydrant in the case assumed.*

MR. DUNHAM:—Mr. President, two things have occurred to me in the reading of this paper. I may not have followed it very closely or understood accurately, and if I am wrong in my inference I would like to be speedily corrected. I did not see that provision was made for extending the fire service outside of the district which was described. That, of course, is something that should always be taken into account in dealing with the construction of a system for a city, and all the pipes throughout should be large enough to provide the required number of streams at a considerable distance from the limits first fixed. Is that an item in this calculation?

MR. TUBBS:—It is an item. Of course I simply determine the size of one main there as an illustration, but you will find that I remark that the size of each main throughout the whole distribution would be determined in a similar manner. Of course, if it includes fire service, each main must be adjusted to performing its duty. Does that answer your question?

MR. DUNHAM:—My point is that it should be adjusted to perform certain duties outside of the district which is referred to, as the city increases in size.

MR. TUBBS:—Oh, yes, sir. I say in the course of the paper it will vary very little, and in an intelligently designed set of works the yearly rental value of a fire hydrant will vary very slightly for a long series of years, but that an occasional readjustment of values should be made. As the hydrants are extended the cost increases, of course, but one balances the other and your relation still remains no matter how much you extend.

MR. DUNHAM:—My other point is in regard to the storage capacity. In this gravity system certain questions are very much simplified. If the water is delivered by pumps and the pressure maintained at thirty or forty pounds for domestic use, and then increased for fire protection, you have a large amount of water pumped through all your connections on account of the fire protection that you offer. That is, in a city where you are pumping, we will say, three or four hundred gallons per minute for domestic consumption, if it is required to furnish water for fire at a pressure of 125 pounds, the first three or four hundred gallons per minute become, possibly, fifteen hundred gallons, and that would be an item which would affect the storage capacity required. Just as an illustration, I can mention a fire where twenty-one hours of steady pumping were required, and whilst only five streams or such a matter were furnished, the actual amount of water pumped was about two thousand gallons a minute, which would call for a storage capacity of something like 2,400,000 instead of 800,000. And this was in a town not very different in size from the one mentioned.

MR. TUBBS:—Of course all this is left to the judgment of the engineer. When he is getting these items together he must be sufficiently familiar with the town, its pipeage, and the probable number of streams that will be required, to design his reservoir large enough for all such contingencies. I do not expect this to be a guide for anybody in figuring, except in so far as it indicates methods.

MR. DIVEN:—Mr. President, the principal difficulty I see in this is to get a Common Council with sufficient intelligence to understand it all. That is a rare thing.

MR. TUBBS:—I have prepared this paper for two reasons. I believe it has been a subject of discussion in

this Associations in previous years; I think it has been a subject of discussion in the New England Water Works Association. I know that in the hundreds of towns in which syndicates have built water works and are taking a hydrant rental, it is extremely important, not only to the investor whom these syndicates or companies request to buy their bonds or their securities, but it is also extremely important to the municipality itself, to know or to have some fair, reasonable method, of determining what *are* fair rentals.

There comes in another element in the case, and it is one that will appeal to the water works people of Cleveland, as well as all other towns owning their own water works. The usual practice is for the municipality owning its works to use all the water it pleases for public purposes and make no return on the books of the department, and now there is a crying demand from almost every water department that reasonable credits be put upon the books for the valuation of public water. I have been fortunate enough to induce my own city to give us a credit of $100,000 a year for public use of water, and I succeeded in doing it on this basis: I worked out the system and was enabled to show the people that we were justly entitled to something like those figures. If you have no system they say that you are guessing at it, and it don't make any difference any way, the municipality owns it and has to pay for it. But if you can go before them and say, "We have actually earned this money, gentlemen, on a fair, reasonable computation," then, as it is a mere matter of book-keeping, you are very likely to succeed in getting your credits.

MR. DUNHAM:—I would like to inquire, in the case of Rochester, where the value of fire service is fixed at $100,000, the number of hydrants, or what is that per hydrant?

MR. TUBBS:—This $100,000 does not include hydrant rental only; it includes various other uses. We have between 1700 and 1800 hydrants, and they are rated at something over $50 apiece on these figures.

MR. DENMAN:—Mr. Chairman, I found it impossible to follow the reader and take in the paper as it should be considered, but I did not perceive that Mr. Tubbs had made any allowance or attempted to make any allowance for the *moral benefit* that ensues from the presence of a fire hydrant. The insurance companies have what they

call a "moral risk," a "moral hazard." Now, a water company is entitled to pay for what might be called the *moral benefit* that arises from the presence of a fire hydrant.

There is another factor that I cannot eliminate from the consideration of the subject, and that is the uncertainty of the quantity of water that is to be consumed. It may be a little fire, or it may be a large one. It may be the destruction of your pumps where you are pumping by direct lines. You may by your contract have to pump for six streams, or you may have to pump for ten or twenty. The accidents that may come to a pumping works from the abnormal quantity of water which we are always liable to be called upon to furnish, should, I think, be taken in and considered as a factor in this paper. The fact, is, I think, that the best way out of the dilemma, to settle the question of value, if you can, is to get a good round sum per mile and let the city put on as many hydrants as it pleases. It seems to me that that is the better way to do it.

Col. Gardner offered the following resolution:

Resolved, That the Committee on Publication of Proceedceedings take necessary steps looking toward the collection of prints and drawings which have been placed on exhibition, and such others as they may be able to procure gratuitously, with a view to future publication; that the associate and active members be requested to furnish drawings and prints of interest to the Association and in the line of our work.

Adopted.

The Secretary stated that there was no such committee as a "Committee on Publication;" whereupon Col. Gardner moved that the "Committee on Publication" referred to in the foregoing resolution consist of Col. Fanning and Mr. Decker.

Seconded and carried.

Adjourned.

AFTERNOON SESSION, THURSDAY, APRIL 19, 1888.

Meeting called to order by Prest. Fanning at 2:30 o'clock.

REPORT OF NOMINATING COMMITTEE.

The Committee on Nominations beg leave to recommend the following persons to serve the Association for the ensuing year:

For President.—A. N. Denman, of DesMoines, Iowa.

For Vice-Presidents.—J. N. Diven, of Elmira, N. Y.; W. G. Richards, of Atlanta, Ga.; Jno. W. Henion, of Minneapolis, Minn.; Chas. N. Priddy, of Leadville, Col.; H. W. Ayres, of Hartford, Conn.

For Secretary and Treasurer.—J. H. Decker, of Hannibal, Mo.

For Finance Committee.—Frank W. Holly, of Lockport, N. Y.; F. L. Fuller, of Boston, Mass.; Thos. N. Hooper, of Davenport, Iowa.

For the Committee, L. H. GARDNER, Ch'n.

Report on motion accepted.

On motion, chairman of committee cast ballot of Association for the nominees of the committee, who were then declared the officers for the ensuing year.

Col. Gardner offered and moved the adoption of the following resolution:

Resolved, That the thanks of the Association are hereby tendered to Col. J. T. Fanning, for his services as President during the past year, which have resulted in so pleasant and so profitable a meeting as that which is now closing.

Carried unanimously by a standing vote.

Col. Gardner also offered and moved the adoption of the following resolution:

Resolved, That the thanks of the Association be and are hereby tendered to Mr. C. E. Burke, for his kind and hospitable attention to the ladies who have accompanied our members, and for other special courtesies, which we will remember with gratitude.

Unanimously adopted, by a rising vote.

Mr. Diven offered a resolution of thanks to the Committee of Arrangements and Reception.

Adopted.

Mr. Denman offered the following resolution:

Resolved, That the thanks of this Association are due and are hereby heartily tendered to John Whitelaw, Esq., and to the Engineer's Club of Cleveland, of which he is President, for the excellent paper read by Mr. Whitelaw before this Association at the City Hall last evening, for diagrams presented and

for the exhibition of the working model of the Crib, and for other information given in response to questions from our members. Also to W. A. Madison, Esq , Secretary of Cleveland Water Board, for his paper relating to water work accounts, also presented at the same meeting, which was of great interest to the members of our Association.

Resolved, That the Secretary be requested to procure a copy of each of these papers for publication in our annual proceedings.

Adopted.

PLACE OF NEXT MEETING.

Mr. Diven nominated Baltimore, Mr. Gerecke Chicago, Mr. Richards Atlanta, Mr. Decker (by request of Mr. F. A. W. Davis) Indianapolis, Mr. Tubbs Rochester, Prest. Fanning (by request of Mr. Hermany) Louisville.

Moved and seconded that the Association proceed to an informal ballot, after which a formal ballot be taken on the cities having the three highest ballots, all others being dropped. Seconded and carried.

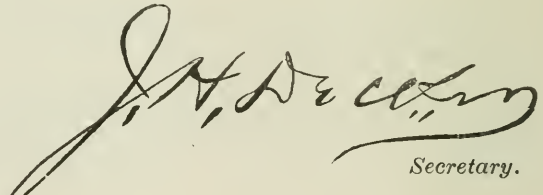
Mr. Holme and Mr. Fuller were appointed tellers.

The informal ballot resulted: Atlanta, 19; Louisville, 15; Chicago, 6; Rochester, 3; Baltimore, 3; Indianapolis, 3.

Louisville was selected on the second formal ballot, which stood: Louisville, 26; Atlanta, 23.

A vote of thanks was moved and adopted to the gentlemen inviting the Association to meet at other cities.

Adjourned.



Secretary.

THE EXHIBITS.

In response to the invitation issued in the circular of the Association, a very gratifying and a very interesting exhibition of Water Works Appliances was held. The corridor of the second floor of the hotel, leading to the parlors, was given up for the use of the Associate Members who availed themselves of the privilege to occupy every inch of the space. The corridor was at all times crowded and a capital opportunity was afforded for introducing any novelty in machinery to the superintendents. The following firms were represented either by members of the firm or by one or more agents, and an unlimited amount of trade literature.

FIRE HYDRANTS AND VALVES.

FIRM.	REPRESENTATIVES.
Chapman Valve Mfg. Co., Indian Orchard, Mass.	W. R. Billings
Ludlow Valve Mfg. Co., Troy N. Y.	City agents
R. D. Wood & Co., Philadelphia, Pa.	Allen T. Prentice
Holly Mfg. Co., Lockport, N. Y.	Frank W. Holly
Richard Beaumont, Kankakee, Ill.	R. Beaumont
Walter S. Payne & Co., Fostoria, Ohio.	Agent
Rouse & Hills Co., Cleveland, Ohio.	Mr. Hills
Galvin Brass & Iron Works, Detroit, Mich.	Chas. D. Lynch

BRASS GOODS, STOP BOXES, ETC.

J. B. Clow & Sons, Chicago, Ill.	Firm
W S. Payne & Co., Fostoria, Ohio.	Agent
Fred. Adee & Co., New York, N. Y.	Agent
Rouse & Hills Co., Cleveland, Ohio.	Mr. Hills
Bingham & Taylor, Buffalo, N. Y.	City Agent
Ted Wortley & Co., Kansas City, Mo.	Frank M. Potter
A. W. Morgan, Buffalo, N. Y.	A. W. Morgan
H. Mueller & Sons, Decatur, Ill.	H. Mueller
Jarvis B. Edson, New York, N. Y.	W. T. Harris

OILS.

E. H. Kellogg & Co., New York, N. Y. ..... C. H. Hammond

METERS.

H. R. Worthington, New York, N. Y.	S. A. Welch
National Meter Co., New York, N. Y.	Jno. C. Kelley, Pres't C. S. Brown.
Union Water Meter Co., Worcester, Mass.	J. P. K. Otis
Hersey Meter Co., South Boston, Mass.	J. A. Tilden, Sup't

FILTERS.

Oliphant's Filter, New York, N. Y.	Wm. Oliphant
Jewell Pure Water Co., Chicago	R. H. Dalzell, Mgr.

CAST IRON PIPE, ETC.

R. D. Wood & Co., Philadelphia, Pa.....A. T. Prentice
Lake Shore Foundry, Cleveland, Ohio.....C. E. Burke, Sec'y
Shickle, Harrison & Howard Co., St. Louis, Mo.....C. P. Allen

PUMPING MACHINERY.

Holly Mfg. Co., Lockport, N. Y.....F. W. Holly
H. R. Worthington, New York, N. Y.....Chas. A. Hague, J. P. Maxwell
Hall Electric Pump, Plainfield, N. J.....Geo. H. Frost

TECHNICAL PRESS REPRESENTED.

Engineering News, New York, N. Y.....Geo. H. Frost, C. E. and Stenographer
Eng. and Bldg. Record, New York, N. Y.....F. W. Skinner, C. E.
Fire and Water, New York, N. Y.....F. W. Shepperd

THE BANQUET.

(Extract from the Cleveland Daily Papers.)

The crowning event of the meeting took place last evening in one of the dining rooms of the Hollenden. The occasion was the annual banquet, and it was graced by the presence of several ladies, the wives and friends of the members. Among them were: Mrs. William Ryle, Mrs. J. M. Diven, Mrs. Reuben Getz, Miss Mima Ryle, Mrs. Amos Morgan, Mrs. B. F. Stephens, Mrs. A. N. Denman, Mrs. I. N. DeWitt, Mrs. William Starkweather and Mrs. C. E. Burke. At one side of the room hung a large banner, on which were the words "American Waterworks Association."

It was 9 o'clock when the seventy ladies and gentlemen sat down to the tables, which were arranged to form three sides of a square. The menu was long and varied and was thoroughly enjoyed. Mr. J. H. Decker acted as toast master. The first toast was "The City of Cleveland," response by Mayor Babcock. The Mayor said he was entirely taken by surprise. He welcomed the visitors and extended a cordial greeting and the freedom of the city. "Cleveland," he said, "has become noted as a proper and convenient place for holding conventions, and we have hoped that this fact would become more generally known, and that the feeling of hospitality which its citizens entertain would become a recognized fact throughout the land." The Mayor thanked the association for inviting him to speak, and regretted that he was not better prepared.

"The Press," the next toast, was responded to by George H. Frost, of New York, proprietor of the *Engineering News*. He said he was glad to meet so many gentlemen whom he knew by reputation.

he thought, had given very able reports of the convention, and the association had been very handsomely treated, particularly by the papers, as compared with the treatment that had been received at other places. His connection with the press was with the technical journals, which make the business and welfare of science their especial study. He expressed a wish for the prosperity of the association, and hoped the next meeting would be better attended even than the present one.

Colonel Fanning, the past president, was next called upon. He acknowledged the courtesy of Cleveland in entertaining its guests.

Mr. L. H. Gardner was the next speaker, and he made a few happy remarks upon things in general. He said he loved most, next to eating and drinking, to hear men who can talk, and next to that, to hear himself talk. He had a revenge to wreak upon mankind, and proposed to do it by making a speech. He called down imprecations upon the chemists who are continually analyzing water and showing how impure it is.

The next speaker called upon was H. W. Ayres, but he excused himself, and Mr. W. G. Richards was invited to speak. His few remarks were quite witty and evoked considerable laughter. President-elect Denman was the next speaker. He expressed his thanks to the members for having elected him to preside over the association for the coming year. He spoke of the pleasure of occasions like the present. He looked forward with pleasure to the next meeting.

Mayor Babcock extended an invitation to the members and their ladies to pay a visit to-day to the Masonic Temple after their return from the tour of the city. Mr. Decker returned thanks to the Mayor in behalf of the association for his invitation. Charles A. Hague spoke briefly, and Colonel J. W. Henion, B. F. Stephens and others followed.

Friday morning was most profitably and pleasantly spent in visiting the Lake Shore Foundry, Fairmount Reservoir and High Service Pumping Station, Garfield's Monument and Tomb, and various other points of interest, thus closing one of the best meetings in the history of the association.

IN MEMORIAM.

WILLIAM C. STRIPE,

CIVIL ENGINEER, KEOKUK, IOWA.

DIED FEBRUARY 27, 1888.

W. C. STRIPE was born in Woolwich, England, January 18th, 1812, and was the son of Wm Stripe, a civil engineer of marked ability. He was educated in Liverpool. In 1840 he came to the United States Embarking on a ship called the John Taylor, which was wrecked in a severe storm off the Island of Cuba, he with other passengers, were picked up by another vessel and landed at New Orleans. From there he went to Fort Madison, Iowa, where he embarked in business, remaining until 1851, when he removed to Keokuk. He was engaged in various branches of business there until the breaking out of the war when he was appointed Deputy U. S Revenue Collector, and retained the position until the office was abolished. He was for several years Assistant Engineer on the construction of the government canal at the Des Moines rapids, on the Mississippi at Keokuk, and was in charge of the most important part of the construction. He prepared the plans for the water works system of Keokuk, and personally engineered their construction, and remained in charge as Secretary and Superintendent of the Company until the works were sold a short time before his death During the winter of 1880-81 he conceived the idea of organizing an Association of Water Works Engineers and Superintendents. After considerable correspondence he issued the following call:

S. P. POND, PRESIDENT. W. C. STRIPE, SEC'Y & ENG'R.

KEOKUK WATER WORKS.

KEOKUK, Iowa, Feb. 1st, 1881.

DEAR SIR—Having been requested to take the initiative in calling a Convention of Superintendents of Western Water Works, you will confer a favor by advising me by return mail whether the project meets your approval—whether you will attend, and at what city you would prefer the Convention to be held

Respectfully yours, W. C. STRIPE

This resulted in calling a convention to meet at the Washington University, St. Louis, Mo., March 29th, 1881, and the organization then and there of THE AMERICAN WATER WORKS ASSOCIATION, and justly entitling him to be called the "Father of the Association," a title in which he took great pride He was at the organization elected First Vice-President and subsequently re-elected to the same position three consecutive times; his interest in the Association never abated, and he was only deterred from attending its later meetings by the increasing infirmities of age. He was a man of more than ordinary learning, thoroughly versed in all matters pertaining to his profession. In all the relations of life his conduct was that of uprightness and courteous and honorable dealing with those who had either social or business intercourse with him Particularly genial and social he commanded the respect and love of all who truly knew him, and of none more sincere than from the writer and his family.

He was taken ill with Pleuro Pneumonia February 17th and died February 27th, after an illness of but ten days.

He leaves wife and seven children, Frederick H , of Chicago, Mrs. Laura Zwart, of Des Moines, Iowa, George M , Assistant Engineer Water Works, Keokuk, Frank W., Harry B., Lida, and Mary, to all of whom this Association tenders its most sincere and tender sympathies, and unite with them in bewailing the loss of one so near and dear, and to whom we present this small token of our esteem.

IN MEMORIAM.

JOHN RYLE,

PRESIDENT PASSAIC WATER CO., PATERSON, N. J.

DIED NOVEMBER 6, 1887.

JOHN RYLE was born in the village of Bollington, near Macclesfield, England, October 22nd, 1817, and died after a brief illness, of Apoplexy, at Macclesfield, England, where he was visiting with his daughter, Miss Jemima, November 6th, 1887.

At a very early age he was put to work in a silk mill. His only book learning he received in the Sunday schools, where secular as well as religious training was given. Before he reached the age of twelve years he became an orphan: he, however, remained in the silk factory, mastering the trade in all its branches.

In March, 1839, he sailed for America. After a tempestuous voyage of seven weeks he landed in New York The next year, 1840, he took charge of a silk mill at Paterson, N. J., for Mr. George W. Murray, and established the first successful silk mill in this country. In 1843 he became a partner in the concern, and in 1846 bought out Mr. Murray's interest, becoming sole owner. In 1869 the mill was burned to the ground, but was rebuilt in its present form and the Ryle Silk Manufacturing Co. organized, with John Ryle as President; this afterward became the Pioneer Silk Co. Mr. Ryle owning the controlling stock became its President, which office he retained until his death. In 1869 he was elected Mayor of Paterson. He was the originator and builder of the Paterson Water Works. Owning three-fourths of the stock he was made President of the Company, retaining the position up to the time of his death In 1882 he with William, his son, Superintendent of the Water Works, became members of this Association, and those who attended the Boston meeting in 1885 will not soon forget his genial and kindly smiles In June, 1887, he sailed for England, in company with his daughter, Miss Mima, who is present with us at this meeting. While in Macclesfield, on Sunday morning, November 6th, last, he was seized with a fit of Apoplexy while dressing and expired within a few minutes. His remains were brought to this country on the steamship Umbria and he was buried from the Second Presbyterian Church, Paterson, N. J. Politically he was a Democrat, and in religion an earnest and consistent Presbyterian. At his death he was a widower, but four sons and one daughter survive him, Reuben, Superintendent Pioneer Silk Mills, Allentown, Pa., William, Superintendent Water Co., Paterson, N. J., Peter, a lawyer in Paterson, and Thomas, Superintendent Pioneer Silk Mills, Paterson, N. J., and Miss Jemima, of Paterson, to all of whom we tender our fraternal sympathies and mourn with them in their sorrow.

FINANCIAL REPORT.

1887.				Dr.	Cr.
July 13.	Balance cash on hand			$ 230 00	
"	Andrew Bergstrom,	Entrance	Fee,	5 00	
"	W. A. Bixby,	"	"	5 00	
"	C. S. Drummond,	"	"	5 00	
"	W. H. Getchell,	"	"	5 00	
"	R M. Jones,	"	"	5 00	
"	H. E. Keeler,	"	"	5 00	
"	Chas. F. Loweth,	"	"	5 00	
"	Frank F. Moody,	"	"	5 00	
"	H. C. Parrott,	"	"	5 00	
"	R. C. Pearsons,	"	"	5 00	
"	H. S. Van Cleve,	"	"	5 00	
"	John Weller,	"	"	5 00	
"	W. H. Willard,	"	"	5 00	
"	Galvin Brass & Iron Wks,	"	"	10 00	
"	The Volker & Fethousen Mnfg. Co.,	"	"	10 00	
"	W. A. Bixby,	Dues to	1888,	3 00	
"	R. M. Jones,	"	"	3 00	
"	H. C. Parrott,	"	"	3 00	
"	R. C. Pearsons,	"	"	3 00	
"	The Volker & Felthousen Mnfg. Co.,	"	"	3 00	
"	W. G. Richard,	"	"	3 00	
"	I. L. Lyman,	"	"	3 00	
"	G. W. Pearsons,	"	"	3 00	
"	C. N. Priddy,	"	"	3 00	
"	F. W. Holly,	"	"	3 00	
"	P. H. Linneen,	"	"	3 00	
"	H. F. Gaskell,	"	"	3 00	
"	Jno. W. Troy,	"	"	3 00	
"	H. R. Worthington,	"	"	6 00	
"	J. W. Henion,	"	1887,	3 00	
"	Chas. Hood,	"	"	3 00	
"	W. J. Milner,	"	"	3 00	
"	A. N. Denman,	"	"	3 00	
"	J. B. Clow & Sons,	"	"	3 00	
"	Wm. Ryle,	"	"	3 00	
"	John Ryle,	"	"	3 00	
"	G. E. Beach,	"	"	3 00	
"	H H. Harrison.	"	"	3 00	
"	B. F. Jones,	"	"	3 00	
"	National Tube Wks Co.,	"	"	3 00	
"	J. G. Briggs,	"	"	3 00	
"	J. Albert Mills,	"	"	3 00	
"	Philip Buehner,	"	"	3 00	
"	R. D. Wirt,	"	"	3 00	
"	J. P. Donahue,	"	"	3 00	
"	Thos H. Hooper,	"	"	3 00	
"	N Kuhnen,	"	"	3 00	
"	Phinehas Ball,	"	"	3 00	
"	Union Water Meter Co.,	"	"	3 00	

1887.				Dr.	Cr.
July 13.	N. O. Nelson Mnfg. Co.,	Dues to	1887,	$ 3 00	
"	E. S. Wills,	"	"	3 00	
"	Geo. H. Chandler,	"	"	3 00	
"	C. E. Gray,	"	"	3 00	
"	B. F. Stephens,	"	"	3 00	
"	H. Mueller,	"	"	3 00	
"	R. D. Wood & Co.,	"	"	3 00	
"	Jno. M. Diven,	"	"	3 00	
"	P. J. Neagle,	"	"	3 00	
"	Wm. Bowen,	"	"	3 00	
July 25.	M. L. Holman,	"	"	3 00	
"	Alex. Richmond,	"	"	6 00	
"	Dennis Long & Co.,	"	"	3 00	
"	J. D. Cook,	"	"	3 00	
July 26.	Cinn & Newport I. & P. Co.,	"	"	3 00	
July 27.	The Eddy Valve Co ,	"	"	3 00	
"	H. C. Heermans,	"	"	3 00	
"	H. Birkinbine,	"	"	3 00	
"	Davis, Cresswell & Co.,	"	"	3 00	
"	J. T. Fanning,	"	"	3 00	
"	D. C. Fry,	"	"	3 00	
"	A. J. Jones,	"	"	3 00	
"	Ludlow Valve Mfg. Co.,	"	"	3 00	
"	The Ohio Pipe Co.,	"	"	3 00	
"	The Michigan Pipe Co.,	"	"	3 00	
"	The Equitable Meter Co.,	"	"	3 00	
July 28.	R. C. P. Coggeshall,	"	1888,	6 00	
"	R. Holme, Sr.,	"	1887,	3 00	
"	R. Holme, Jr.,	"	"	3 00	
"	W. R. Billings,	"	"	3 00	
"	J. J. R. Croes,	"	"	3 00	
"	Newark Filtering Co.,	"	"	3 00	
"	F. A. W. Davis,	"	"	3 00	
"	Geo. F. Blake Mfg. Co.,	"	"	3 00	
July 29.	Robert Moore,	"	"	3 00	
"	Bingham & Taylor,	"	"	3 00	
"	L. H. Gardner,	"	"	3 00	
"	J. D. Houston,	"	"	3 00	
"	Edwin Darling,	"	"	3 00	
"	Gordon Maxwell Co.,	"	"	3 00	
July 30.	Reading Iron Works,	"	"	3 00	
"	E. H. Kellogg & Co.,	"	"	3 00	
"	Fred Adee & Co.,	"	"	3 00	
"	Hays Mfg. Co.,	"	"	3 00	
"	L. Halsey Williams,	"	"	3 00	
"	Chapman Valve Mfg. Co.,	"	"	3 00	
"	J. M. Randall,	"	"	3 00	
Aug. 1.	R. G. Elwes,	"	1888,	6 00	
"	Geo. F. Swain,	"	1887,	3 00	
"	Geo. B. Inman,	"	"	3 00	
"	J. Henry Brown,	"	"	3 00	
"	Ezra Clark,	"	1888,	3 00	
"	H. W. Ayres,	"	"	3 00	
"	Abendroth & Root,	"	1887,	3 00	
"	Wm. Ludlow,	"	"	3 00	
Aug. 2.	Robt. K. Martin,	"	"	3 00	

1887.			Dr.	Cr.
Aug. 3.	W. S. Payne,	Dues to 1887,	$ 3 00	
"	A F. Kent,	" "	3 00	
Aug. 4.	Hardwicke & Ware,	" "	3 00	
"	Frank Schefold,	" "	9 00	
"	J. L. Mott Iron Works,	" "	3 00	
Aug. 6.	L. A. Taylor,	" "	3 00	
"	W. S. Kuhn,	" "	3 00	
Aug. 9.	A. W. Morgan,	" "	3 00	
"	J. H. McMinn,	" "	3 00	
Aug. 10.	L. J. LeConte,	" "	3 00	
"	Columbus W. W.,	Fees & dues to '88,	13 00	
Aug. 15.	W. H. Marsh, Agt..	Dues to 1887,	3 00	
"	Aug. Schaeffer,	" "	3 00	
Aug. 16.	R. A. Robertson, Jr., Agt.,	Fees & dues to '88,	13 00	
Aug. 17.	E. H. Brown,	Dues to 1887,	3 00	
"	Lewis C. Burnes,	" "	3 00	
Aug. 19.	Ripley & Bronson,	" "	3 00	
"	Shickle, Harrison & Howard Iron Co.,	" "	3 00	
Aug. 20.	J. A. Cloud,	" "	3 00	
"	B. M. Espy,	" "	3 00	
Aug. 25.	Wm. H. Burnham,	" "	3 00	
"	F. L. Fuller,	" "	3 00	
Aug. 27.	Wm. B. Sherman,	" "	3 00	
"	Desmond Fitzgerald,	" "	3 00	
Sept. 1.	Chas. A. Hague,	" "	3 00	
Sept. 7.	John Martin,	" "	3 00	
Sept. 13.	Wm. T. Porter,	" "	3 00	
"	F. Wm. Ræder.	" "	6 00	
Sept. 15.	Frank H. Pond,	" "	3 00	
Sept. 19.	W. G. Provines,	" "	3 00	
Oct. 1.	T. S. Moorhead,	" 1888,	6 00	
"	Jones & Laughlin,	" 1887,	3 00	
Oct. 3.	Whitney Conant,	Fees & dues to '88,	8 00	
Oct. 21.	H. G. Holden,	Dues to 1887,	3 00	
Oct. 27.	Jno. C. Chase,	" "	3 00	
Oct. 29.	J. H. Andrew,	" "	3 00	
Nov. 5.	Jno. W. Hill,	" "	3 00	
Nov. 9.	Wm. B. Bull,	" "	3 00	
Nov. 21.	H. S. McConnell	" "	3 00	
Nov. 29.	Jno. B. Quigley,	Fees & dues to '89,	8 00	
"	M Joy, Jr.,	Dues t3 1887,	3 00	
Dec. 7.	Walter Watson,	" "	3 00	
Dec. 13.	Chas. Elliott,	Fees & dues to '89,	8 00	
"	W. C. McConnell,	" " "	8 00	
Dec. 15.	W. W. Sprague,	Dues to 1887,	3 00	
Dec. 21	C. A. Metheaney,	Entrance Fee,	5 00	
Dec. 31.	Chas. H. Nettleton,	Fees & dues to '89,	8 00	
"	M. T. Stookey,	" " "	8 00	
"	Geo. W. Breckenridge,	" " "	8 00	
1888.				
Jan. 2.	R. M. Gow,	Dues to 1887,	6 00	
"	Isaac W. Brooks,	Fees & dues to '89,	8 00	
"	A. B. Gaines,	" " "	8 00	
Jan. 4.	Alex. G. Cattell,	" " "	8 00	
"	Geo. H. Robertson,	" " "	8 00	
Jan. 7.	W. H. Wheeler,	Entrance Fee,	5 00	

1888.			Dr.	Cr.
Jan. 7.	H. D. Wood,	Dues to 1887,	$ 3 00	
Jan. 10.	H. F. Dunham,	" "	3 00	
"	E. H. Keating,	" 1888,	6 00	
Jan. 13.	H C. Hodgkins,	Fees & dues to 89,	8 00	
"	A. L. Brown,	" " "	8 00	
"	D. M. Clark,	" " "	8 00	
Jan. 16.	A. R. Leeds,	" " "	8 00	
"	Timothy Woodruff,	" " "	8 00	
"	B. R. Morton,	Dues to 1888,	3 00	
Jan. 19.	Henry C. Pitney,	Fees & dues to '89,	8 00	
Jan. 23.	Howard Elmer,	Dues to 1888,	3 00	
Jan. 25.	F. P. Doyle,	Fees & dues to '89,	8 00	
Jan. 26.	Geo. A. Ellis,	Dues to 1888,	3 00	
Jan. 27.	P. M. Hanley,	Fees & dues to '89,	8 00	
"	Sylvanus Ayres, Jr.,	" "	8 00	
Feb. 1.	Edwin Shepard,	Entrance Fee,	5 00	
"	J. A. Polhamius,	Fees & dues to '89	8 00	
Feb. 11.	J. N. Chambers,	" " "	8 00	
Feb. 16.	Wm. Molis,	Dues to 1888,	3 00	
Feb. 18.	Jas. McWilliams,	Fees & dues to '89,	8 00	
Feb. 22.	Donald F. Campbell,	" " "	8 00	
"	Lake Shore Foundry,	" " "	13 00	
Feb. 25.	A. H. Howland,	Dues to 1887,	3 00	
"	H. M. Newton,	" 1888,	3 00	
"	John Weller,	" "	3 00	
Feb. 27.	Carl Schon,	on acc't " "	10 00	
"	S. Bent Russell,	Fees & dues to '89,	8 00	
Mar. 9.	J. B. Johnson,	Dues to 1887,	3 00	
Mar. 16.	W. H. Messinger	Fees & dues to '89,	8 00	
Mar. 19.	Geo. H. Utter,	" " "	8 00	
"	Wm. H. Watts,	" " "	8 00	
"	Ted Wortley & Co.,	Dues to 1888,	6 00	
Mar. 27.	J. M. Carson,	" "	12 00	
Apr. 2.	D. C. Fry,	on acc't " 1889,	5 00	
Apr. 11.	Y. Nakajima, contribution,		5 00	
"	Sales Proceedings,		7 90	
"	" A. H. Denman Paper,		3 35	
1887.				
July 13.	Paid Porterage on Books.....			$ 50
July 17.	" " "			50
"	" Telegram.....			1 05
"	" Express charges.....			50
July 22.	" Postage.....			4 00
July 29.	" Express charges.....			65
Aug. 1.	" Postage.....			3 00
Aug. 10.	" Collection of Checks.....			25
Sept. 10.	" Telegram.....			60
Sept. 19.	" Postage.....			3 00
Oct. 5.	" Collection of Checks.....			15
Nov. 3.	" Postage.....			20 00
"	" Express charges.....			1 00
Nov. 9.	" Postage.....			2 00
Nov. 12.	" Express charges.....			95
Nov. 26.	" Telegram.....			50
"	" M. P. Yocum, stenographic rep't			47 55
Dec. 14.	" Express charges.....			85

1888.			Dr.	Cr.
Jan. 10.	Paid	Standard Ptg. Co., Proceedings, etc.....		283 30
Jan. 25.	"	Postage.....		1 00
Jan. 28.	"	Telegram.....		50
Feb. 14.	"	Postage.....		2 00
Mar. 10.	"	Drayage.....		25
Mar. 12.	"	R. R. Rate Circulars.....		3 00
Mar. 16.	"	" " "		1 50
"	"	Express charges.....		25
"	"	Telegram.....		50
Mar. 20.	"	"		40
"	"	Postage.....		2 00
Mar. 26.	"	Express charges		45
"	"	Telegram.....		50
Mar. 30.	"	Postage.....		14 00
Apr. 3.	"	"		2 00
Apr. 11.	"	Standard Ptg. Co., Notices, Badges, &c...		40 10
Apr. 17.	"	J. T. Fanning, Pres, Printing & Postage.		234 99
"	"	J. H. Decker, Salary.....		250 00
		Balance Cash on hand.....		171 55
			$1095 25	$1095 25

LIST OF MEMBERS.

HONORARY.

Y. Nakajima, Imperial University.....Tokio, Japan

ACTIVE.

Allen, Chas. P., Engineer Waterworks.....Denver, Col
Andrew, Jas. H., Sup't Waterworks.....Central Falls, R. I
Archer, James, Water Co. .....Denver, Col
Ayres, H. W., C. E. Waterworks.....Hartford, Conn
Ayres, Sylvanus Jr., Manager Waterworks....Bound Brook, N. J
Babcock, S. E., C. E. Waterworks.....Little Falls, N. Y
Ball, Phinehas, Hydraulic Engineer.....Worcester, Mass
Beach, G. E., Hydraulic Engineer.....Minneapolis, Minn
Bement, R. C. B., Chief Eng. Duluth Water Co.....St. Paul, Minn
Benzenburg, G. H., Chief Eng. Water Dep't.....Milwaukee, Wis
Bergstrom, Andrew, Mech. Eng. Waterw'ks..Minneapolis, Minn
Birkinbine, Harry C. E. Waterworks .....Council Bluffs, Ia
Bixby, Walter A., Superintendent Waterworks.....Galena, Ill
Bond, Joseph A., Chief Eng. Water Dep't.....Wilmington, Del
Bowen, Wm., Superintendent Waterworks.....Oskaloosa, Ia
Breckenridge, G. W., President Water Co.....San Antonio, Tex
Briggs, J. G., with J. B. Clow & Sons.....Chicago, Ill
Brooks, Isaac W., President Water Co.....Torrington, Conn
Browere, Edward A., M. E. Waterworks.....Catskill, N. Y
Brown, A. L., M. E. Waterworks.....Salem, Oregon
Brown, Calvin S., with National Meter Co.....New York, N. Y
Brown, E. H.....Grass Valley, Cal
Brown, Geo. W., Superintendent Waterworks.....Longmont, Col
Brown, J. Henry, Sup't Mystic Div. Water Dep't....Boston, Mass
Brush, Chas. B., C. E. and Sup't Waterworks.....Hoboken, N. J
Buehner, Phillip, Waterworks Contractor.....Portland, Oregon
Bull, Wm. B., Superintendent Waterworks.....Quincy, Ill
Burnes, L. C., Secretary Water Co.....St. Joseph, Mo
Cameron, W. L., Sec'y and Supt. Waterworks.....Memphis, Tenn
Campbell, D. F., Sup't Water Co.....Traverse City, Mich
Carson, J, M., C. E. and Sup't Waterworks..... .....Danville, Ill
Cassin, Isaac S., Hydraulic Engineer.....Philadelphia, Pa
Cattell, Alex. G., President Water Co.....Merchantville, N. J
Caulfield, John, Secretary Water Board.....St. Paul, Minn
Chambers, J. N., M. E. Waterworks.....Birmingham, Ala
Chandler, Geo. H., Engineer Waterworks..... Kalamazoo, Mich
Chase, John C., C. E. and Sup't Waterw'ks.....Wilmington, N. C
Chipman, Willis, Chief Engineer Water Co.....Brockville, Ont
Clark, D. M., Sec'y and Treas. Water Co..... ..... Elyria, Ohio
Clark, Ezra, Pres't and Supt. Water Commission...Hartford, Conn
Cloud, J. A., Constructing Engineer.....Jacksonville, Fla
Coggeshall, R. C. P., Sup't Waterworks.....New Bedford, Mass
Conant, Whitney, Secretary Water Co.....Long Branch, N. J
Cook, J. D., Consulting Engineer.....Toledo, Ohio
Cook, Edward C., Constructing Engineer.....Tiffin, Ohio

Croes, J. J. R., Consulting Engineer.....New York, N. Y
Darling, Edwin, Superintendent Waterworks....Pawtucket, R I
Davis, F. A. W., V.-Pres. and Treas. Water Co...Indianapolis, Ind
Decker, J. H., Engineer and Supt. Water Co.....Winfield, Kas
Denman, A. N., Secretary Water Co.....DesMoines, Ia
Diven, J. M., Sec'y and Treas. Water Co.....Elmira, N. Y
Donahue, Jas. P., Vice-Pres. and Supt. Water Co...Davenport, Ia
Doyle, F. P., Sec'y and Sup't Water Co..... Petaluma, Cal
Drummond, C. S., Director Water Co.....Winnipeg, Can
Dunbar, E. L., Sec'y and Sup't Waterworks.....Bay City, Mich
Dunham, H. F., Consulting Engineer..... Cleveland, Ohio
Eaton, Frederick, Consulting Engineer.....Los Angelos, Cal
Elliott, Chas., City Superintendent Water Co...SanFrancisco, Cal
Ellis, Geo. A., Civil Engineer.....Boston, Mass
Elmer, Howard, Pres't Sayre, Pa., Water Co .....Waverly, N. Y
Elwes, R. Gervase, Civil and Consulting Engineer..London, Eng
Espy, B. M., Sec'y and Treas. Waterworks ..... Wilkesbarre, Pa
Fanning, J. T., Civil and Consulting Eng.....Minneapolis, Minn
Fisher, Wm , Sup't Waterworks..... .....Marshalltown, Ia
Fitzgerald, Desmond, C. E. and Sup't Water Dep't..Boston, Mass
Fritchman, W. H., Sup't Water Co..... .....Stevens Point, Wis
Frost, E. W., Sup't Waterworks..... .....Colorado Springs, Col
Fry, D. C. Sup't Waterworks..... Jacksonville, Ills
Fuller, F. L., Constructing Engineer..... .....Boston, Mass
Gaines, A. B., President Water Co .....Hot Springs, Ark
Gardner, L. H., Superintendent Water Co.....New Orleans, La
Gerecke, F. W., Chief Eng. Water Dep't.....Chicago, Ill
Getchell, W. H., Sec'y Fairbault Water Co.....Minneapolis, Minn
Glover, A. S., Water Registrar..... .....Newton, Mass
Godard, A. A., President Water Co.....Clay Centre, Kas
Gow, R. M., Superintendent Waterworks..... Medford, Mass
Hague, C. A., Mec. Eng. with H. R. Worthington..New York, N. Y
Hamilton, W. S., Sup't Waterworks.....Youngstown, Ohio
Hanley, P. M., Superintendent Waterworks.....Fort Madison, Ia
Hanna, J. L., Prest. and Manager Water Co.....Franklin, Pa
Hannah, Jos. E., Eng. and Sup't Waterworks.....Winnipeg, Can
Harlow, Geo. R., Constructing Engineer..... ..Pittsburg, Pa
Harper, Louis, Sup't of Construction..... .Rapid City, Dak
Harris, S. W., M. E. Waterworks..... .....Racine, Wis
Harris, W. T., Sec'y and Treas. Water Co.....Jackson, Tenn
Harrison, H. H. Sup't Waterworks.....Stillwater, Minn
Heermans, H. C. Sup't Waterworks.....Corning, N. Y
Hely, John P., Civil and Hydraulic Engineer.....St. Louis, Mo
Henion, J. W., ...Minneapolis, Minn
Henderson, Wilson, Sup't Waterworks.....Peterborough, Ont
Hering, Rudolph.....New York, N. Y
Hill, John W., Mech. Eng.....Cincinnati, Ohio
Hodgkins, H. C., Contracting Engineer.....Watertown, N. Y
Holden, H. G., Sup't Waterworks.. .....Nashua, N. H
Holland, D. L., M. E..... Saratoga Springs, N. Y
Holly, Frank W., Mechanical Engineer.....Lockport, N. Y
Holman, M. L., Water Commissioner..... ..... St. Louis, Mo
Holme, Richard, Sec'y and Sup't Water Co.....Denver, Col
Holme, Richard, Jr., Cashier Water Co.....Denver, Col
Hood, Chas., Superintendent Waterworks.....Burlington, Ia
Hooper, Thos. N., Chief Engineer Waterworks.....Davenport, Ia
Hornung, Geo., Civil Engineer.....Newport, Ky

Howland, A. H., Constructing Engineer.....Boston, Mass
Inman, Geo. B., Contracting Engineer.....New York, N. Y
Johnson. J. B , Prof. Civil Eng. Washington Univ...St. Louis, Mo
Jones, A. J.....New Brunswick, N. J
Jones, B. F., Sup't Water Co..... Kansas City, Mo
Jones, J. I..... .....Kansas City, Mo
Jones, R. M.. Manager Waterworks.....Wyandotte, Kas
Joy, Moses, Jr., President Water Co.....Petersburg, Va
Judson. Chas. A., Sup't Waterworks..... .....Sandusky, Ohio
Keating, E. H., City Engineer.....Halifax, Nova Scotia
Keeler, H. E., Director Charleston, Ill., Water Co ....Chicago, Ill
Kent, A. F., Pres't and Sup't Water Co.....Jamestown, N Y
Kuhn, W. S., Contracting Engineer..... ...McKeesport, Pa
Kuhnen, N., Pres't Water Co..... Davenport, Ia
Lakin, John T., Sup't Waterworks ..... Rockford, Ill
LeConte, L. J., Civil and Consulting Engineer.....Oakland, Cal
Leeds, Albert R., Consulting Chemist.....Hoboken, N. J
Linneen, P. H., Mechanical Engineer.....Lockport, N. Y
Loweth. Chas. F.. Civil Engineer.....St. Paul, Minn
Ludlow, Wm., C. E.....Philadelphia, Pa
Lyman, I. L., Comm'r and Sup't Waterworks.....Lincoln, Neb
McCanne, D. J , Sup't Waterworks.....Gunnison, Col
McClary, W. F., Sup't Waterworks.....Mt. Pleasant, Ia
McConnell, H. S., Sec'y Water Co..... .....New Brighton, Pa
McConnell, W. C., Pres't Water Co..... .....Shamokin, Pa
McElroy, Samuel, Civil Engineer.....Brooklyn, N. Y
McMinn, J. H., Sup't Waterworks..... .Williamsport, Pa
McWilliams, James, Sup't Water Co.....Seattle, Wash. Ter
Manning, Chas. F., Sup't Waterworks.....Hagerstown, Md
Martin, John, Engineer Waterworks....St. Johns, Newfoundland
Martin, Robert K , Chief Engineer Water Dep't...Baltimore, Md
Martine, A. H. Eng. and Sup't Waterworks.....Knoxville, Tenn
Maxwell, J. P., Civil Engineer..... .....Boulder, Col
Messinger, W. H., Chief Engineer Water Co .....Lynn, Mass
Metheany, C. A., Sec'y and Sup't Water Co..... Lima, Ohio
Mills, J. Albert, Sup't Waterworks..... St. Catherines, Ont
Mills, Wm. B., Pres't Water Co..... Denver, Col
Milne, Peter, Jr., Consulting Engineer.....New York, N. Y
Milner, W. J., Sec'y and Sup't Waterworks.....Birmingham, Ala
Molis, Wm., Sup't Waterworks.....Muscatine, Ia
Moody, Frank F., Registrar Water Dept.....Minneapolis, Minn
Moore, A. G., Engineer and Sup't Water Dep't..... Cincinnati, O
Moore, D. F., Sup't Waterworks .....Phœnixville, Pa
Moore, Robert, Civil Engineer..... .....St. Louis, Mo
Moorhead, T. S., Civil and Hydraulic Engineer.....Arcadia, Fla
Morley, Philip, Sup't Water Co.....East Liverpool, Ohio
Morse, C. W., Sup't Waterworks.....Haverhill, Mass
Morton, B. R., C. E. and Sup't Waterworks.....Newport, Ky
Murdock, Gilbert, C. E. and Sup't Waterworks...St. Johns, N. B
Neagle, P. J., Sup't Waterworks.....Elmira, N. Y
Nelttleton, C. H., Agent Water Co.....Birmingham, Conn
Neville, Thos. J., Water Registrar.....Rochester, N. Y
Newton, H. M., Sec'y and Sup't Waterworks..East Saginaw, Mich
Noyes, A. F., Chief Engineer Waterworks..... ..Newton, Mass
Parrott, H. C., Mechanical Engineer.....Lockport, N. Y
Pearsons, G. W., Civil Engineer.....Kansas City, Mo
Pearsons, R. C., M. E.....Kansas City, Mo

Perkins, P. B., Contracting Engineer.....Springfield, Mo
Perry, Wm. Jr, Constructing Engineer.....Montreal, Quebec
Phipps, E. H., Sup't Waterworks.....West Haven, Conn
Pitney, H. C., Pres't Aqueduct Co.....Morristown, N. J
Polhamius, J. A., Pres't Water Co.....Texarkana, Texas
Pond, F H., Mechanical Engineer.....St. Louis, Mo
Porter, Wm. T., Pres't Board Water Com'rs.....Wilmington, Del
Price, Chas. G., Cashier for Water Co.....Hannibal, Mo
Priddy, Chas. N., Sec'y and Sup't Waterworks.....Leadville, Col
Quigley. J. B., Pres't Water Co.....Sedalia, Mo
Ræder, F. Wm., Consulting Engineer.....St. Louis, Mo
Randell, J. M., Sup't Waterworks.....East Orange, N. J
Richards, W. G., Sup't Waterworks.....Atlanta, Ga
Richmond, Alex., Sup't Street Dep't Waterworks...Raliegh, N. C
Rinker, Andrew, City Engineer.....Minneapolis, Minn
Robertson, Geo. H., Sup't Waterworks.....Yarmouth, N. S
Robinson, Geo. W., Director of Water Co.....Winfield, Kas
Russell, S. Bent, Ass't Eng. Water Dep't.....St. Louis, Mo
Ryle, Wm., Superintendet Water Co.....Paterson, N. J
Sawyer, J. T., President Water Co.....Waverly, N. Y
Schæfer, August, Sup't Waterworks.....Maysville, Ky
Schefold, Frank, Sup't Waterworks.....New Albany, Ind
Shepard, Edwin, Manager Water Co.....Seattle, Wash. Ter
Sheppard, F. W., "Fire and Water".....New York, N. Y
Schon, Carl, Civil Engineer.....Toledo, Ohio
Searles, W. H., Civil and Consulting Engineer...Cleveland, Ohio
Sekell, A. C., Consulting Engineer.....Grand Rapids, Mich
Sherman, W. B., Mechanical Engineer.....Providence, R. I
Shields, Geo. A., Superintendent Waterworks.....Pueblo, Col
Smith, Herbert L., Sup't Waterworks.....Norfolk, Va
Snow, Eugene J., Constructing Engineer.....Brooklyn, N. Y
Sprague, W. W., Chief Eng Waterworks.....Town of Lake, Ill
Stauffer, D. Mc. N., C. E., Ed. "Eng. News".....New York, N. Y
Stephens, Benj. F., Constructing Engineer.....Flatbush, N. Y
Stevens, G. C.....Jeffersonville, Ind
Stookey, Matt, Gen. Mgr. Waterworks.....Belleville, Ill
Swain, Geo. F., Prof. C. E. Mass Inst. of Tech.....Boston, Mass
Tayler, John W., Sup't Waterworks.....Newcastle, Pa
Taylor, L. A., Constructing Engineer.....Boston, Mass
Troy, John W., Superintendent Waterworks.....Pierre, Dak
Todd, John R., Registrar Water Dep't.....Norfolk, Va
Tomlinson, Samuel, Dep. Ex. Eng. Waterw'ks.....Bombay, India
Tubbs, J. Nelson, Chief Eng. Waterworks.....Rochester, N. Y
Utter, Geo. H., Pres't Water Co.....Silver City, N. M
VanCleve, H. S., Dir. Pierre, Dak., Water Co..Minneapolis, Minn
Wadsworth, A. R, Sup't Waterworks.....Farmington, Conn
Walker, J. S., Chief Engineer Waterworks.....Birmingham, Ala
Walsh, Matt, Sup't Waterworks.....Minneapolis, Minn
Waltz, Jos. E., City Engineer.....Dayton, Ohio
Waters, James, Chief Eng. Waterworks.....Minneapolis, Minn
Watson, Walter, Civil Engineer.....Pittsfield, Mass
Watts, W. H., Sup't Waterworks.....El Paso, Texas
Watts, Sylvester, Contracting Engineer.....St. Louis, Mo
Weller, John, Inspector Waterworks.....East Saginaw, Mich
Wheeler, W. H., Sup't Waterworks.....Beloit, Wis
Willard, W. H., Sup't Waterworks.....Eau Claire, Wis
Williams, L. H., Sec. & Treas New Castle Water Co...Pittsburg, Pa

Wills, E. S., Superintendent Water Co.....Atchison, Kas
Wiltsie, Myron, Engineer of Construction.....Rapid City, Dak
Wing, Fred, Cashier for Water Co.....Kansas City, Mo
Wingfield, N., Chief Eng. Waterworks.....Chattanooga, Tenn
Wirt, R. D., Superintendent Waterworks.....Independence, Mo
Wood, H. D., Sec. and Treas. Hannibal Water Co...St. Louis, Mo
Woodruff, Timothy, Sup't Waterworks.....Bridgeton, N. J.
Young, John, Civil Engineer.....Geneseo, N. Y

ASSOCIATE.

Adee. Fred & Co., No. 52 Cliff st.....New York, N. Y
Addyston Pipe & Steel Co.....Cincinnati, Ohio
Beaumont, Richard.....Kankakee, Ill
Bingham & Taylor, Clinton & Jackson sts.....Buffalo, N. Y
Blake, Geo. F., Mfg. Co., Nos. 95–99 Liberty st...New York, N. Y
Chapman Valve Mfg. Co.....Indian Orchard, Mass
Chattanooga Foundry & Pipe Works.....Chattanooga, Tenn
Clow, J. B. & Sons, Lake and Franklin sts.....Chicago, Ill
Columbus Water Works.....Columbus, Ohio
Connelly, P., No. 351 Adams st.....Brooklyn, N. Y
Davidson Steam Pump Co., No. 41–51 Keap st.....Brooklyn, N. Y
Dean Steam Pump Co.....Holyoke, Mass
Eddy Valve Mfg. Co.....Waterford, N. Y
Edson, Jarvis B., No. 91 Liberty st.....New York, N. Y
Equitable Water Meter Co., No. 36 India Wharf.....Boston, Mass
Galvin Brass and Iron Works.....Detroit, Mich
Gaskell, H. F., Holly Mfg. Co.....Lockport. N. Y
Gordon Maxwell Co.....Hamilton, Ohio
Hall Electric Pump Co.....Plainfield, N. J
Hardwicke & Ware.....Buffalo, N. Y
Hays Mfg. Co.....Erie, Pa
Hersey Meter Co.....Boston, Mass
Jewell Pure Water Co., Lake and Franklin sts.....Chicago, Ill
Jones & Laughlins, No. 28 West Lake st.....Chicago, Ill
Kellogg, E. H. & Co., No. 243 South st.....New York, N. Y
Kupferle, John C.....St. Louis, Mo
Lake Shore Foundry.....Cleveland, Ohio
Long, Dennis & Co.....Louisville, Ky
Ludlow Valve Mfg. Co.....Troy, N. Y
McNeil, A. H.....Burlington, N. J
Marsh, W. H., Man. Tuerk Hydraulic Power Co..New York, N. Y
Michellon, J. P.....Camden, N. J
Michigan Pipe Co.....Bay City, Mich
Morgan, A. W., No. 11 Forest Ave.....Buffalo, N. Y
Mott, J. L., Iron Works, No. 88 & 90 Beekman st..New York, N. Y
Mueller, H.....Decatur, Ill
National Meter Co., No. 252 Broadway.....New York, N. Y
National Tube Works Co.....McKeesport, Pa
Nelson, N. O., Mfg. Co., 8th and St. Charles sts.....St. Louis, Mo
Newark Filtering Co., Tribune Building.....New York, N. Y
Ohio Pipe Co.....Columbus, Ohio
Oliphant, Wm.....Jersey City, N. J
Payne, W. S.....Fostoria, Ohio
Reading Iron Works, Nos 16 and 18 North 5th st..Philadelphia, Pa
Reliance Oil & Grease Co.....Cleveland, Ohio
Richards, H. De C.....Jersey City, N. J

Ripley & Bronson, Nos. 907–911 North Main st.....St. Louis, Mo
Robertson, R. A. Jr., Agent.....Providence, R. I
Rouse & Hills Co.....Cleveland, Ohio
Shickle, Harrison & Howard Iron Co.....St. Louis, Mo
Strang, Samuel A., No. 30 Pine st.....New York, N. Y
Union Water Meter Co.....Worcester, Mass
Volker & Felthousen Mfg. Co.....Buffalo, N. Y
Wood, R. D. & Co., No. 400 Chestnut st.....Philadelphia, Pa
Worthington, H. R., Nos. 86 and 88 Liberty st...New York, N. Y
Wortley, Ted & Co.....Kansas City, Mo

Report of Proceedings

OF THE

NINTH ANNUAL MEETING

OF THE

American ✻ Water ✻ Works

ASSOCIATION,

HELD AT

LOUISVILLE, KENTUCKY,

April 16th, 17th and 18th, 1889.

SALINA, KANS.:
A. G. WELSHER, PRINTER.
1890.

OFFICERS FOR 1889-90.

President.

J. H. DECKER. - - - - - Salina, Kans.

Vice-Presidents.

W. G. RICHARDS. - - - - - Atlanta, Ga.
WILLIAM RYLE. - - - - Paterson, N. J.
H. G. HOLDEN. - - - - Nashua, N. H.
W. L. CAMERON. - - - - Memphis, Tenn.
CHAS. N. PRIDDY. - - - Leadville, Colo.

Secretary and Treasurer.

J. M. DIVEN. - - - - - Elmira, N. Y.

Finance Committee.

JAS. P. DONAHUE. - - - - Davenport, Iowa.
WM. MOLIS. - - - - - Muscatine, Iowa.
W. S. HAMILTON. - - - - Youngstown, O.

Past Presidents.

A. N. DENMAN. - - - - Des Moines, Iowa.
B. F. JONES, - - - - - Kansas City, Mo.
PETER MILNE, JR. - - - - New York, N. Y.
L. H. GARDNER. - - - - New Orleans, La.
J. G. BRIGGS. - - - - Indianapolis, Ind.
J. T. FOSTER. - - - - - - Chicago, Ill.

Standing and Special Committees.

General Arrangements.

L. H. GARDNER, 49 Baronne St., - New Orleans, La.
G. H. BENZENBERG, Water Dep't. - Milwaukee. Wis.
CHAS. A. HAGUE, 86-88 Liberty St., - New York, N. Y.
A. W. MORGAN, 11 Forest Ave., - - Buffalo, N. Y.
JNO. C. KELLEY, 252 Broadway, - New York, N. Y.

Local Arrangements.

P. H. LINNEEN, Home Ins. Bld'g. - - Chicago, Ills.
A. J. GUILFORD, Tacoma Building, - - - " "
H. E. KEELER, National Tube Works, - " "
R. H. DALZELL, Lake and Franklin St's., - " "
A. T. PRENTICE, 190 Cass St., - - - " "

On Badges.

J. M. DIVEN, - - - - - Elmira, N. Y.
L. H. GARDNER, - - - - New Orleans, La.
Wm. RYLE, - - - - - Paterson, N. J.

Electric Boiler Device.

Wm. B. BULL, - - - - - Quincy, Ills.
P. H. LINNEEN, - - - - - Chicago, Ills.
J. P. DONAHUE, - - - - Davenport, Iowa.

Standard Cast Iron Water Pipe.

S. BENT RUSSELL, - - - - St. Louis, Mo.
SHICKLE, HARRISON & HOWARD IRON CO., " "
DENNIS LONG & CO., - - - Louisville, Ky.

INDEX.

Analysis of Mechanical Filter Actions (Illustrated) 63
Election of Officers 126
Entertainment 130
Financial Statement 135
Flushing Street Mains 21
In Memoriam 134
List of Members 139
Members Present 6
New Members Elected 8–128
Notes on Some Matters Connected with the Distribution of Water in Cities (Illustrated) 103
Officers for 1889-'90 2
Place of Next Meeting 125
President's Address 11
Pressure Regulators for Water Mains (Illustrated) 38
Pure Feed Water for Boilers 110
Relations Between Plumbers and Water Companies 126
Report of Proceedings 3
Report of Committee of Resolutions 117
Report of Executive Committee 9
Report of Nominating Committee 126
Report of Secretary and Treasurer 10
Resolutions 117–128
Standing and Special Committees 3
Suggestions on the Advantages of Sewerage to Water Companies. 23
Should a City or Town Provide Meters at its own cost to Consumers of Water 42
Standard Water Pipes 90
The Hardness of Water 120
The Exhibits 129
The Bauquet 131
The Excursion to Mammoth Cave (Illustrated) 131
Use of Liquid and Gaseous Fuels 24
Water Works Records 18

REPORT OF THE PROCEEDINGS

OF THE

NINTH ANNUAL MEETING

OF THE

AMERICAN WATER WORKS

ASSOCIATION.

AT LOUISVILLE, KENTUCKY.

MORNING SESSION, TUESDAY, APRIL 16, 1889.

The meeting was called to order in the parlors of the Galt House at 10:30 o'clock, by the President, A. N. Denman, Esq.,

MR. REINECKE of Louisville: Mr .President and gentlemen of the American Water Works Association, I desire to introduce to you the Mayor of the city of Louisville, Hon. Chas. D. Jacob, who desires to extend to you that welcome in behalf of the City of Louisville which belongs to you as visitors to our city, and I am satisfied that there will be but one regret in his address, and that is this: that he is not also our jailor that he might lock you up and keep you here.

MR. JACOB: Mr. President and gentlemen of the Association: Having heard accidentally this morning while at breakfast one of your number remark that he thought he would take a nap to-day "so as to be ready for them to-night" I recognized the fact, without knowing exactly what he did mean, that you are a lot of business men assembled together for the purpose of discussing in a limited time matters of importance and interest to yourselves, and I shall not detain you longer than to say to you that it gives me very great pleasure to greet and welcome you to the city of Louisville,

where. if your local authorities are not able to do all our friend Mr. Reinecke would desire, I will add that the whole power of this tremendous municipal government shall be at their back to sustain them in their efforts to see that nothing shall be left undone to contribute to your happiness and comfort. I am glad to meet you Mr. President and gentlemen of the association. (applause).

The President:—In behalf of the association I desire to express to you, Mr. Mayor, our sense of obligation for your kindness and for the hospitality which it is evident we are to meet with at the very outset of our proceedings. We shall remember you with grateful hearts. The association will now proceed with the regular order of business. The first business in order is the calling of the roll.

Upon the call of the roll by the Secretary. the following members respond.

ACTIVE.

Ayres. H. W.....Hartford, Conn.
Bond. Joseph A.....Wilmington. Del.
Briggs. J. G.....Indianapolis. Ind.
Brown. Calvin S.....Toledo, Ohio.
Bull. Wm. B.....Quincy, Ill.
Cameron. Wm. L.....Memphis, Tenn.
Darling. Edwin.....Pawtucket, R. I.
Decker. J. H.....Salina, Kas.
Denman. A. N.....Des Moines, Ia.
Diven. J. M.....Elmira, N H
Donahue. James P.....Davenport. Ia.
Gardner. L. H.....New Orleans. La.
Hamilton. W. S.....Youngstown, Ohio.
Harris. W. T.....Jackson. Tenn.
Henion. Jno. W.....Minneapolis, Minn.
Holden. H. G.....Nashua, N. Y.
Hood. Charles.....Burlington, Ia.
Hornung. Geo.....Cincinnati. Ohio.
Johnson. Prof. J. B.....St. Louis, Mo.
Jones. B. F.....Kansas City, Mo.
Jones. R. M.....Kansas City, Kans.
Keeler. H. E.....Chicago, Ill.
Kent. A. F.....Jamestown, N. Y.
Linneen. P. H.....Chicago, Ill.
Martine. A. H.....Knoxville. Tenn.
Milner. W. J.....Birmingham, Ala.
Molis. Wm.....Muscatine, Ia.
Monjeau. C.....Cincinnati, Ohio.
Moore. A. G.....Cincinnati, Ohio.
Morley. Philip.....East Liverpool, Ohio.
Morton. B. R.....Newport. Ky.
Priddy. Chas. N.....Leadville. Colo.
Reyer. Geo.....Nashville. Tenn.

Richards, W. G.....Atlanta, Ga.
Russell, S. B.....St. Louis, Mo.
Ryle, Wm.....Paterson, N. J.
Schaeffer, August.....Maysville, Ky.
Schefold, Frank.....New Albany, Ind.
Sheppard, F. W.....New York, N. Y.
Stookey. M. T.....Belleville, Ill.
Taylor, Jno. W.....New Castle, Pa.
Walker, J. S.....Birmingham, Ala.

ASSOCIATE.

Addyston Pipe & Steel Co.....Cincinnati, Ohio.
Chapman Valve Mfg. Co.....Boston, Mass.
Clow, J. B. & Sons.....Chicago, Ill.
Columbus Water Co.....Columbus, Ohio.
Deane Steam Pump Co.....Holyoke, Mass.
Galvin Brass & Iron Works.....Detroit, Mich.
Hall Electric Pump Co.....Plainfield, N. J.
Hersey Meter Co.....New York, N. Y.
Holly Mfg. Co.....Lockport, N. Y.
Jewell Pure Water Co.....Chicago, Ill.
Kellogg, E. H. & Co.....New York, N. Y.
Long, Dennis & Co.....Louisville, Ky.
Ludlow Valve Mfg. Co.....Troy, N. Y.
Morgan, A. W. Mfg. Co.....Buffalo, N. Y.
Mueller, H.....Decatur, Ill.
National Meter Co.....New York, N. Y.
National Tube Works Co.....McKeesport, Pa.
Newark Filtering Co.....New York, N. Y.
Oliphant, Wm.....New York, N. Y.
Rouse & Hills Co.....Cleveland, Ohio.
Shickle Harrison & Howard Iron and Steel Co.....St. Louis, Mo.
Tuerk Hydraulic Power Co.....Chicago & New York.
Union Water Meter Co.....Worcester, Mass.
Wood, R. D. & Co.....Philadelphia, Pa.
Worthington, H. R.....New York, N. Y.

THE PRESIDENT:—Mr. A. F. Callahan of the firm of Dennis Long & Co., desires to communicate with you on a matter of vital interest, and we will make way for him now.

MR. CALLAHAN:—Mr. President and gentlemen of the association, I shall only take up enough of your time to tender a couple of invitations to the associations. The first is from the Louisville Water Company through its chief engineer, Mr. Hermany which reads:

OFFICE OF
LOUISVILLE WATER COMPANY.

LOUISVILLE, KY., Apr. 16th, 1886.

TO THE AMERICAN WATER WORKS ASSOCIATION,
Galt House, City.

GENTLEMEN:—The Louisville Water Company extends a cordial invitation to the members of the above Association, now assembled

in convention, to visit the Reservoir and Pumping Station belonging to the system of water supply of the City of Louisville.

To accomplish this purpose, a passenger train will leave from the First & Water Streets' Depot at two o'clock P. M. Thursday, the 18th. inst., to visit Crescent Hill Reservoir; thence returning to the city and up to the Pumping Station, which two trips, will take about four hours.

It is hoped that all the members will find it convenient to go as above indicated. If the time named is not consistent with the business arrangements of the Convention, the Company will be glad to make different or such arrangements as will meet the convenience of the members.

Very Respectfully
LOUISVILLE WATER COMPANY,
By CHAS. HERMANY,
Chief Eng. & Supt.

Mr. Hermany said he would like to hear from the Convention in reply to the invitation as soon as practicable, in order that proper arrangements may be made, and if the time designated by him should not meet the convenience of the associrtion to advise him of what other time will. I also desire in the name of Dennis Long & Co. to extend an invitation to the association to join us on an excursion to Mammoth Cave. We have arranged to leave here on Friday morning by special train at nine o'clock, and returning you will reach Louisville on Saturday evening about nine o'clock. We have figured it that most of the members ought to be in a position to avail themselves of the invitation, because if you leave here promptly on adjourning you could not get to your homes to attend to any business before Monday morning, and very few of you live so far that you cannot go on this trip and still reach home by that time. Every arrangement will be made for the comfort and pleasure of the members on the excursion. Of course, you understand that this invitation includes the ladies.

MR. DIVEN:—I move that the invitation of the Louisville Water Company be referred to the Executive Committee. Our time is going to be very fully taken up, and I think it will take some little deliberation to see whether we can go. I move also, that the thanks of the association be tendered for both invitations.

The motions being put they were unanimously carried.

The Secretary reported the following applications for membership, all of which were, upon motion, received and the applicants unanimously elected:

ACTIVE.

Barnet, John, Supt. Water Works.....Lafayette Ind.
Burnet Muscoe, Supt. & Treas. Water Co.....Paducah, Ky.

Cole, John A., Civil Engineer,.....Hyde Park, Ill.
Foote, C. M., Civil Engineer,.....Minneapolis, Minn.
Geyelin, Emile, Hydraulic Engineer,.....Philadelphia, Pa.
Hermany, Chas., Chief Eng. & Supt. Water Works...Louisville, Ky.
Jackson, F. W., Supt. Water Works .....Oak Park, Ill.
McAlpine, A. H., Chief Eng. & Supt. Water Works Columbus, Ohio.
McCallum, Alex, Hydraulic Engineer,.....Philadelphia, Pa.
Marrett, P. J., clerk to chief engineer..... Louisville, Ky.
Martin, H. P., Sup't Water Works .....Owensboro, Ky.
Ogden, John L., Chief Engineer Water department...Philadelphia, Pa.
Potts, Isaac B., Mechanical Engineer.....Columbus, Ohio.
Race, R. T., Pres't Fredonia, Kans., Water Works.....Irving Park, Ills.
Reinecke, Wm., Sec'y Ashland, Wis., Water Works.....Louisville, Ky.
Ruger, Edward, Chief Eng. Water Works..... .....Omaha, Neb.
Wilkerson, J. H., Supt. Water Works.....Bowling Green, Ky.

ASSOCIATE.

Ahrens & Ott Mfg Co. Water Works Supplies,.....Louisville, Ky.
Bourbon Brass and Iron Works Water Works Supplies....Cincinnati, O.
Caldwell, Jno. A., M. E., Hyatt Pure Water Co.....New York, N. Y.
Clark, Wm. L., Newark Tapping Machine.....Newark, N. J.
Fisher Governor Co., Manufacturers Steam Pumps... Marshalltown, Ia.
Water Waste Prevention Co., Water Meters..... New York, N. Y.

THE PRESIDENT:—The next business in order is the reading of the minutes of the last meeting, and it is suggested that heretofore it has been the custom to omit this. There being no objection the reading of the minutes is dispensed with.

MR. GARDNER:—I move that the officers of the Louisville Water Company, and all members of scientific bodies resident in the city of Louisville, be accorded an invitation to attend our meetings and to participate in our debates.

The motion was seconded and being put was carried.

THE PRESIDENT:—The next order of business is the report of the Executive Committee.

The Secretary then read the report as follows, which on motion was approved:

REPORT OF EXECUTIVE COMMITTEE.

TO THE MEMBERS OF THE AMERICAN WATER WORKS ASSOCIATION:—

GENTLEMEN:—Your Executive Committee would respectfully report:

That they have examined the accounts of the Secretary and Treasurer, and find the same to be correct as reported by him.

That they have fixed the salary of the Secretary and Treasurer at three hundred dollars ($300.) for the past year, and have authorized him to draw a warrant for that amount.

We would recommend that all members delinquent in their dues for three years or over be dropped from the roll with privilege of reinstatement at any time upon payment of all arrearages.

Respectfully submitted.

A. N. Denman, Pres't.

For Executive Committee.

Louisville, Ky., April 16th 1889.

The Secretary read the report of the Secretary and Treasurer as follows:

REPORT OF SECRETARY AND TREASURER.

To the Officers and Members of the American Water Works Association:—

Gentlemen:—I have the honor to submit herewith my Ninth Annual Report as Secretary and Treasurer of the Association.

Since our last Annual Meeting we have lost from our ranks by death, Mr. Harvey F. Gaskell, representing the Holly Manufacturing Co.

During the year we have gained 24 Active and 7 Associate Members; we have lost by resignation 7 Active and 1 Associate, dropped from the rolls for non-payment of dues 14 Active and 4 Associate, leaving a net gain of 5 Members. There are now enrolled, 1 honorary, 223 Active and 56 Associate, a total of 280 Members.

CASH STATEMENT.

Balance on hand last report		$171 55
Rec'd from Admission Fees	$185 00	
" " Annual Dues	587 00	
" " Sales of Proceedings	29 05	
		$801 05
Total from all sources		$972 60

DISBURSEMENTS.

Paid warrant No. 38 in favor H. F. Dunham Acc't Expense 8th Annual Meeting	$ 5 00	
Paid warrant No. 39 in favor Davis & Hipperd Stenographic report	81 25	
Paid warrant No. 40 in favor Standard Ptg. Co. Proceedings and Stationary	364 22	
Paid warrant No. 41 in favor A. G. Welsher. Notices and Badges	30 72	
Paid warrant No. 42 in favor J T. Fanning Electrotype plates	59 93	
Paid warrant in favor J. H. Decker. Sec'y Office Expense and Postage	108 40	
Paid warrant in favor of J. H. Decker Salary	300 00	
Balance Cash on hand	23 08	
		$972 60

With hearty and sincere thanks to my fellow officers and the members and with an earnest and heartfelt prayer for an interes ng and profitable meeting, as well as for the growth and prosperity of the Association this is Respectfully submitted

J. H. Decker,
Secretary and Treasurer.

Louisville, Ky., April 16th, 1889.

It was moved that the report be approved and placed on file, and it was so ordered.

The President:—The next order of business is the report of the Finance Committee, but there appearing to the chair to be no member of that committee present, the special committees will be called. Has the Committee of Arrangements any report to make?

Mr. Gardner:—The General Committee on Arrangements has no report to make at the present time. It will probably ask leave to report later.

The President:—Gentlemen, members of the American Water Works Association, the office of President is a somewhat peculiar one, and one of its peculiarities is that if he does not seize his opportunity and charge on you according to programme he is apt to loose it altogether. I will therefore at this time submit to the association what remarks I have to make, which may not perhaps come strictly within the line of a President's Address:

THE PRESIDENT'S ADDRESS.

Members of the American Water Works Association:—Gentlemen:—

We have reached our 9th Anniversary. When a youth reaches the age of 21, men are apt to say he is a man and invest him at once with the dignity of a citizen. He takes on the responsibilities of life—has come out from under his tutors and steps forth for real work.

A child of nine springs is not as a usual thing looked upon with so much of interest because perhaps the crisis of his life has not been reached—yet the nines have properties which pertain to no other number. We can usually pressage the character of the future man by the time he reaches nine years and before he enters his teens.

He betrays those characteristics which foreshadow the future even before attaining so much of age.

Thus it seems that in the life of our Association we have arrived at a point when it behooves us to look at ourselves and consider how much of progress and of good we have attained to, and also to look to the future success of the association, which to us all has been so full of pleasure and profit.

I think that an examination of our records, will show that we have hitherto made great strides in all that pertains to real progress. Not

only in numbers in attendance, but in the character of papers presented and in every other feature a marked improvement has been made. The influence of the association has most certainly been felt in the improved character of the service in cities where our members live, in the superior machinery adopted, in the character of the water furnished as well as in the dissemination of information which could scarcely be obtained in any other way. Added years should increase wisdom; Time is lost if improvement be not made in our management. If we have failed to learn more about mechanics and hydraulics and the law of the case—more about dealing justly with the public and to avoid imposition—more about keeping accounts and the economics of our calling, then we have failed to make best use of our opportunities.

If with united hands and hearts we press on to a common goal and that be one of high aim and achievement—if everyone lends their aid, each in his sphere and according to ability, we need have no fear for the future of an association in whose welfare the entire water drinking public have a lively interest, and to which they ought to be taught to look for the best and most reliable information attainable in regard to all that relates to water and water supply.

The association should by its high character, so establish itself in the confidence of the people as to be at once to them a safe counsellor and a just arbiter of all differences. Our realm is wide. We must be familiar with mechanics and mechanical appliances, with hydraulics and with chemistry—be able to discover impurities, and to detect and arrest that which may prove the germ of disease. In fine there is scarcely any field of investigation in which we may not profitably enter.

Our subject is never exhausted—our realm is unestimated. We must delve in the earth for our product and watch the skies as well. The purveyor is at once a miner and a meteorologist; he is always studying the unknown that he may produce that which is known. He makes plain that which is unseen; he dispenses the water of life to the thirsty and famishing; he is an enemy to disease and filth, and preaches louder than words can express that Cleanliness is next to Godliness—indeed it is a prerequisite; he is a Moses who divides the waters—who strikes the rock that gushing waters may flow; he makes sweet the waters of Marah and subdues the fiery terror of the night; his is to bless not to curse; he sets to every one a portion, and like manna it is provided fresh every day. Mechanics and Art subsist by his labors, but his chief reward is in the rosy faces of children and the blessings of the people.

"He turneth a wilderness into a pool of water
And a dry land into water springs;
And there he maketh the hungry to dwell;
That there he may prepare a city of habitation"
Gas may go out—men can live in darkness;
Cars cease for a time to run, yet men exist;
Fuel may be scarce, yet we may be warmed;
Absence of food may for a time be endured
But water must not cease to run.

I exhort you fellow members not to forget your high calling, which should be infinitily above that of mere money getting, but which includes within its scope in a large degree the safety, health and welfare of those you are appointed to serve.

The various plans and mechanisms for the purification of water are attracting, as they ought to, wide spread attention. Therefore I would bespeak your careful attention to the papers to be presented on this subject. We think the time not far off, when years are considered, when

the public will demand from water purveyors that the water they furnish shall not only be pure and wholesome, but also free from all deleterious properties. When the mechanic, for mechanical purposes, shall have the right to demand water which will not only not clog with mud, but which will not even deposit scale in the boiler. The time is fast approaching when purveyors will be held liable for introducing into a boiler that which shall tend to make its use unsafe. Nor will it require the dawning of the millenium to bring this about, for already experiments have proven partially, at least, the feasibility of such attempts.

The man who discovers a stream of pure water, and places it within reach of a thirsty people, is a benefactor indeed, but him to whom it is given to make an impure stream pure, and to cleanse it of everything deleterious, is one who under Divine guidance has made bitter and disease laden waters sweet, of whom it may be said: "The wilderness and the solitary place shall be glad for him and the desert shall rejoice and blossom as the rose."

Nothing, however, assumes more importance to us, than the grave questions of corporations and trusts, which at present take precedence in the public mind. The nature of these organizations is considerably mixed in the public mind, and readily confounded one with the other. For our present purpose we shall say that a trust is not necessarily a corporation although by a union of corporations a trust, may be formed.

A corporation is that which it is made by the power which formed it and has no power not formally granted to it. "For while the life of a corporation is perpetual," to use the apt words of E. P. Alexander in Scribners Magazine, January, 1889, "its powers are limited and its individuality is constantly changing. It is but an artificial individual existing, for certain purposes only, and as it lacks some human qualities all its methods of doing business are influenced thereby. For instance, having no natural memory, its every and most minute transaction or intent must be officially recorded in its archives by a systematized organization which must apprehend every event as do the senses of an individual."

If it abuses its powers it is amenable to the law under which it was granted. Corporations are of two kinds, public and private. They are both alike creatures of the supreme law making power of the State and since both are composed of men who are human, both are liable to abuse by those in management of them.

It has been said that a corporation has no soul. We think it more wisely said that a corporation hath many souls.

The question as to whether water works in cities should be owned by the city itself or by private corporations seems lately to have received considerable attention from associations similar to our own.

Writers taking the sides of the city and against private corporations, seem to forget that in either case the works are controlled by men of like passions. We fail to see how with like candid and fair treatment the private corporation can be inferior to the city in its management or conduct of its affairs.

It goes without the saying that a city government weak or corrupt enough to charter a water company without at the same time passing restraining laws, is not fit to conduct the affairs of such a company otherwise than to the ruin of both Company and people.

A water company is a quasi public corporation and is governed by its charter in every detail of its business, except that it may make such ordinary and reasonable rules for the conduct of its affairs as are

not inconsistent with an honest purpose and are according to usual laws of trade.

I do not intend here to discuss the question as to whether it is better for public water works to be owned by the municipality or by private corporation. but wish only to call attention to a matter which seems now to be occupying much of public attention. I commend a thorough discussion of the subject to the Association.

I will not repress the observation however that an honest public will eventually secure honest management, even of a private corporation, and further to express the opinion that. municipal corporations and the public are chiefly responsible for the faults of private corporations.

Men are restless, ever seeking change. restless as the ocean tossing about hither and thither without seeming object; as Governor Morris says—"ever hoping for good which is never attained and suspicious of evil rarely realized."

Some interesting cases have been decided during the year. involving the rights of water companies in their various relations, to which I think well to call your attention.

The New Jersey Court of Chancery in a case reported in 15 Atlantic Reporter p. 581, decides that a water company acquires by virtue of its incorporation a right to lay its pipes in public highways and in so doing is only subject to such control of local authorities as is necessary to prevent unnecessary obstruction or interference with public travel; and if two such corparations are formed in a locality to which their charter applies each has precisely the same right to make use of the public highways in conducting its business.

In the "Appeal of the City of Chester" (Pa.) reported in the 8 Atlantic Reporter p. 400, it is held that a water company acquires no exclusive rights unless such are expressly given by statute or by its charter or by its municipal contract. A city is under no obligation to refuse to permit another company to occupy the streets in such event. The hardship and injustice of such a proceeding cannot properly be addressed to the court, but must be considered and determined by the city authorities.

In *Freeport Water Works Company vs Prager* 3 Pa. County Court Reports 371, it was held to be no violation of the exclusive franchise of a water company for the defendant, to allow his neighbors to connect with him when he had before the grant to the company. laid pipes and supplied water through them.

In *Reed vs State* 15 N. E. Reporter p. 735 it is held that if in building a reservoir the State uncovers a bed of gravel and does not take the means to make the same water tight the parties injured thereby can recover damage under condemnation statutes.

As touching the relations of water companies and consumers a number of interesting points have been touched upon although none of the points decided are new. First as to the quality of the water which a company is required to furnish under a charter which says that it shall furnish "pure water." The following is the language of the court:

"If the term "pure water," as found in the act of 1874, is to be taken in the absolute sense, then is that absurd and useless; for we all know that the only way to obtain pure water is by distillation. Water is an absolvent and a solvent, so that it can neither pass over the earth nor through the atmosphere without contracting impurity. How then could the Tonawanda Water Works supply pure water to the inhabitants of Tonawanda, when such is not to be found in the heavens above or the earth beneath? But even comparatively pure water is hard to be obtained in large quantities; for in populous sections of the country

where water works are mostly needed, neither rivers nor smaller streams can be kept entirely clear of sewage. Melting snow contaminates them and rains fill them with mud. The very mountain streams are not free from pollution, nor even the springs that flow from the rocks. These are matters of common observation, and we do not need experts to inform us of them. If we are not to utterly frustrate the act of assembly, we must construe the words "pure water" to mean wholesome, —ordinarily pure. We must use it as it is used by the world at large, and not in its abstract or chemical sense. It is only in this manner that we can reach the legislative intent, and make the act econmically valuable. Under this rule—the rule of sound common sense—we can entertain no doubt of the rectitude of the judgment of the court below. The judgment is affirmed."—*Gordon, Chief Justice in Commonwealth vs) Tonawanda Water-Works, 15 Atl. Rep. 440 (Pennsylvania Supreme Court.)*

A troublesome little question is settled in the *Appeal of Brumm* (Pa. 12 Atlantic Reporter 855, and that is where the consumer by his own wrong, as by refusal to pay a just rate, compels the company to sever his connections, the company is entitled to recover the cost of making the disconnection. It has often before this been decided that the consumer must stand the cost of making his own connections which once have been severed.

This same case also decides that if the charter of the company provides that water rents shall be made a lien on the premises, a grantee may be made liable for his grantors default.

Also that a by-law of the company requiring payment of rates half yearly in advance or the water turned off within sixty days is a valid exercise of the right of the company to make by-laws; and that a municipal corporation which supplies its inhabitants with gas or water, does so in its capacity of a private corporation and not in the exercise of its powers of local sovereignty.

The doctrine that a private consumer cannot recover of a water company the damage caused by fire where the water supply was inadequate and not according to contract with the city has again been fully affirmed in *Becks vs. Kittaning Water Co.* (Pa.) 11 Atlantic Reporter p. 300, with little variety of incident. There was in this case a contract between the city and company for the maintenance of fire plugs and adequate pressure and water supply by the company. Plaintiff was the owner of a brewery which he claimed was destroyed by fire because of the inadequate water supply for which the company was responsible. It was held that the company having no contract with the defendant for that purpose owed him no duty in this respect, and the contract being between the city and the defendant, plaintiff's interest was too remote to sustain his action and the court could not extend the terms of his contract with the water company for a general water supply to cover the extraordinary necessity in case of fire.

We bespeak for our programme your careful attention. It would be difficult to declare which of the subjects on it is most important. They each one merit and doubtless will have your close attention. They embrace all subjects from the inception of a water works to the best methods of keeping its accounts.

Many will miss the stock subject of "Water Waste, its prevention and cure," but it is a subject of no less importance than formerly and lacks yet a full, complete and satisfactory answer.

We will be glad to hear something about "Action of Mechanical Filters" from Mr. Geyelin a subject of growing interest as we have already seen.

We are glad to see the names of S. B. Russell, Professors Leeds and Johnson, strangers hitherto. Our old friend Jones comes to us with a problem and will no doubt tell us something of his wrestling with the plumbers of his city and the final outcome of the Kansas City question which was before us at Cleveland last year.

Mr. Gerecke will enlighten us on "Purification of Water for Boilers," a subject of utmost importance and allied to that of "Hardness of Water." Mr. Priddy comes with an "Increase of Rates," a subject which commends itself most gratefully to us all.

We shall hear from Mr. Ayres of the best methods of "Flushing Street Mains" and from Mr. Ryle as to Pressure. While Mr. Gardner will inform us of the latest improvements in the use of Liquid and Gaseous Fuels." Mr. Darling has kindly promised a paper upon the general use of meters, a subject which is just now forcing itself into attention. A generous feast of fat things is prepared for us. Let us sit down to the banquet with keen appetite and rejoice that water is capable of furnishing so much of pure delight without inebriating.

THE PRESIDENT:---We are now about to take up our regular order of business, the reading of papers we have on hand, and I wish I could command words effective to secure not only the earnest attention of the members to these papers, by their constant attendance here while we are in session, but to have them discussed as briefly, as compatible with thoroughness. There is no one here who need feel backward about asking for the floor for the discussion of these papers. We want it most distinctly and emphatically understood that the associate members have an equal right to this floor in the discussion of any papers that may come up, with the limitation, of course, that the proprieties of the case be observed; that is to say, it would not do to allow advantage to be taken of this privilege for the purpose of advertising wares here, but so far as the free discussion of the papers and their subjects as they come before the association, the associate members have equal rights with the active members; they are accorded that right by the constitution, and while I occupy the chair every associate member will be made to feel that he has the same liberty to get on his feet whenever he may have anything to say, as active members. I want to say another thing. There may be some modest men here to whom something may occur they would like to speak of. Now, to these I say just get on your feet and act as though you were among brethern and friends, as we want a full and cordial expression of opinion on all these subjects. (Applause)

MR. DECKER: I would suggest that now would be the proper time to appoint a committee to nominate officers and select a place of meeting for the next year.

THE PRESIDENT:—Mr. Decker's suggestion has taken me by surprise. I will announce the names after dinner.

Adjourned.

AFTERNOON SESSION TUESDAY APRIL 16, 1889.

Meeting called to order by President Denman at 2:30 o'clock.

The president announced the Committee on Nominations as follows:

L. H. Gardner, New Orleans, La.; H. G. Holden, Nashua; N. H.; C. S. Brown, Toledo, Ohio; Charles Hood, Burlington, Ia; Wm. Ryle, Paterson, N. J.;

THE PRESIDENT:—It is with great pleasure we observe our friend and co-worker, Mr. Nevons, President of the New England Water Works Association, amongst us this afternoon. I will request Mr. Nevons to come forward and take a seat.

MR. NEVONS:—I desire to thank you, Mr. President, for your courtesy.

THE PRESIDENT:—Gentlemen, there has been placed on the desk here a plumbers' bond; it is intended simply as a form, a sample, as a suggestion, if you please, of the right thing for the plumber to sign, if you can get them. (laughter).

If time permits we may perhaps a little later have some discussion on that subject, so I should be glad if you would help yourselves to them. In my experience in water works affairs, I have found great benefit frequently from the blanks I have received from other companies and cities. I never destroy them: I file them away. The thing you think you will never have use for is the thing probably you will have to use on the first occasion. So I would like to see these generally distributed, and if you do nothing else fold them and put them in your pockets; later you may heed them. One thing more. We have received a very generous invitation to go to Mammoth Cave on Friday. Now, it is very desirable that Messrs Dennis Long & Co. who have tendered the excursion to us, should know at as early a moment as possible how many will go, there is here on the desk a book for the purpose of registering the names of the members who will go, so that ample provision may be made for all. It is hardly possible there is any one here who has not heard of Mammoth Cave. It is one of the wonders of the United States;

I may say one of the wonders of the world, and no one can well appreciate what he is doing if he has it in his heart to go away from Kentucky without accepting that kind invitation, and I urge upon you all to go. There is another thing that has come within the range of my observation I notice some of the members are without badges. The rule of this association is that any member meeting another is bound to speak to him and shake hands with him, where they are unacquainted, these badges are for the purpose of identification and the promotion of mutual pleasure, let me exhort you all to the utmost cordiality during our stay here and to make the most of the social side of our meeting. I have neglected heretofore to announce to the Association that Mr. Diven has presented to us this handsome gavel, the first that the association has ever possessed.

A Member:—I move that the gavel be accepted with thanks, but with the regret that the donor seemed to think it necessary to make it heavy enough to knock a man down with. (laughter)

Carried.

Mr Gardner:—Before proceeding to further business the Committee of arrangements wish to announce that it is the intention to have a banquet on Thursday evening, and it is desired that those of the members who propose to attend shall advise the secretary at as early a moment as practicable, that all necessary arrangements may be made.

The President—We will now take up the first paper on the programme, which is "Water Works Records" by Mr. J. M. Diven.

WATER WORKS RECORDS.

There are few, if any, connected with Water Works management, who have not, at some time, felt the need of more complete records of work done. Especially if managing works, designed, built and previously managed by others.

Very much the larger part of a water works plant is buried out of sight. But, though out of sight, by no means out of mind. For no single joint, corporation cock, or any other fixture buried five or more feet below the surface of the streets but what, at the most inopportune moment, may make its presence felt and require immediate attention. Therefore the great need that the maps, plans and records of such work be very complete. So that, from them, we or our successors, can at all times know what is buried in the streets and just where to

dig for it. They should be so clear and explicit that any one could fully understand them, for we do not build for the present only, but for all time.

In building new works the first thing determined upon is the source of supply. Then a correct map of the city or town to be supplied is required. And all through the history of the works this map will play a very important part.

The map being obtained, the pipe system is laid out upon it. And in doing this the future needs should be considered as far as possible.

After determining the amount of water needed at various points, for domestic use, manufacturing, fire protection and probable waste, and *guessing* at the growth in various directions, the sizes of pipes required will be determined upon and the pipe system be laid out on the map. For quick and easy reference different colors and forms are usually used to indicate the different sizes of pipe. In selecting these colors and forms it will be found convenient to select the most simple ones for 6 inch and 8 inch pipe, these usually forming the larger part of the pipe system.

This plan of the pipe system should not only show mains to be laid at the time, but also, an outline of proposed extensions. And in making these extentions, when needed, this plan should be rigorously followed, unless future developments make an increase in size necessary. It should never, from false motives of economy, be reduced.

Gate Valves and Fire Hydrants should next be located and marked on the map, particular prominence being given to the latter, for the convenience of firemen and insurance men.

In making the survey, it will not be much extra work to take levels which should, above and below some central point, be indicated on the map, using fire hydrants as grade stakes. The quantity of water the mains are capable of delivering at various points, with the required pressure, should also be noted on the map. Though for this purpose some form of table would probably be better. But, for myself, I have never been able to devise a satisfactory form.

We will now have a complete picture of the works, and a plan for future developments. But useful as this undoubtedly is, in fact almost indispensible, it is necessarily, except in the case of very small towns on too small a scale to show much of the details. For which purpose other maps and plans, on a much larger scale, must be made. This is usually done by dividing the city by wards, or some other convenient division, and making separate maps of each section. These maps, for convenience are bound in book form.

I have, to some extent, used a form of map, which I can recommend to others, having cement lined, wood, or other make of pipe that frequently have to be replaced in places with cast iron. That is, a map for each street by itself. For these maps, or rather plans, I use a long strip of heavy tracing cloth nine inches wide, drawing the plans to a scale of twenty four feet to the inch, thus representing our forty eight foot street by a two inch space on the map, giving ample room for entering all necessary details.

Judging from the little experience I have had with this form of map it strikes me that it would be excellent for a whole system. As it is capable of showing every detail of the mains, etc., that can be desired. The exact location of the pipes at every point, the location of valves, unconnected branches, corporation cocks, and if thought necessary, the position of every joint could be clearly shown.

The uses to which such detail maps can be put are many.

In addition to a clear plan of the mains and other fixtures in the

street, the property lines can be shown. Lots built upon, being distinguished from vacant lots, by coloring or otherwise, and those supplied with city water by some mark, will show the proportion of houses on each street supplied with the same.

I use for this purpose a city atlas, showing property lines, and indicate premises supplied with city water by application number, thus making the map serve as an index to the application book. And a very handy index it is, often coming to the rescue when all others fail. The "Application Book" referred to is a permanent book. One application serving for the premises through all its changes of ownership, etc.

On one page of this book is a blank form of contract for water supply, which is filled in and signed by owner of property before water connection is made, and is so drawn as to be binding to his heirs or successors. This page also contains space for keeping a record of fixtures and rate, this is kept in pencil, to admit of change whenever additions are made to the plumbing. The opposite page is blank. And on it is kept a complete history of the "Tap." On this page is noted such items as name of plumber who puts in service and plumbs premises; length of service, with a diagram of the location of stop-cock box; change of ownership and tenants; additions to plumbing and when made and who by. It is in fact made, so far as the water supply is concerned, a complete history of the premises.

When new mains are to be laid a map on the single street plan will serve as a working plan for the foreman. And on it, as the work progresses, measurements of unconnected branches and of location of valves should be noted. Also make of valves and hydrants, if more than one kind is used in the works, and kind of pipe, if any except cast iron is used. When main is completed, date that water was turned on, together with any other items of interest connected with it should be noted.

For location of valves something even more explicit and accessible is needed, as they are sometimes needed in a great hurry.

Diagrams, not necessarily drawn to a scale, of the location of each valve, giving figures for distances, will be found useful. They should be made in a strongly bound book, of suitable size to be carried in pocket of Superintendent or foreman, and accompanied by a written description. As such diagrams are easily and cheaply made every man connected with the works who is intrusted with the use of the valve key and is liable to be called upon to shut off water, should be supplied with a copy.

To show what valves are needed to shut off a given district and where to find the diagrams of their location, each book of diagrams should be accompanied with a small map, one drawn to a scale of 800 or 1000 feet to the inch will answer and will be small enough to carry in the book, the streets shown by mere lines, those having mains by red ones others by black—and the valves by numbers corresponding to diagrams in "valve book."

With this book of diagrams and map each man has ready to hand the means of quickly finding all valves necessary to shut off any part of pipe system, which is often very important, for instance, in the case of a bad break, let us say in winter, when in the north our valve-box covers are buried under a foot or two of snow and ice, making it impossible to find them, without exact measurements.

The most convenient and accurate measurement is two diagonal lines taken from prominent objects on opposite corners of streets. I usu-

ally select the Lamp-post and Fire-hydrant as being the most prominent and permanent objects.

The best device I have seen for mounting large maps is the one in the Buffalo N. Y. Water Department. It is the invention, I believe, of Mr. Mann, City Engineer. It consists of two rollers secured to the back of a drafting board and connected together by gearing, so that they turn in opposite directions: the ends of the paper are wound upon these rollers the part on which the map is drawn being exposed on the surface of the board, enough of the paper being wound upon each roller to allow for the required movement of the map in either direction. By turning a crank attached to one of the rollers the map is drawn in one direction and at the same time pushed from the other thus bringing any part of the it convenient position for examination or work without any strain on the paper.

Plans or drawings of Buildings, Reservoirs, Stand pipes and other special features of the works, neatly framed, form a most appropriate decoration for walls of office or engine room.

In undertaking to write this paper it was my intention to collect and describe the various forms used in Water Offices for Applications, Plumbers permits, Account of Water rates etc. But the great variety which I found in these forms made the task a very difficult one and would have made this paper entirely too long. So I will leave this subject for someone else in search of material for a paper, and will guarantee that they will find plenty of material.

Mr. Decker:—I move that in the discussion of all papers read, the time of a member be limited to not exceed three minutes.

Carried.

On motion the invitation of the Louisville Water Company was accepted for Wednesday at 2 o'clock, p. m.

The President:—I desire to make another announcement. The Executive Committee have concluded that it will be necessary to hold a meeting this evening in order that we may get our business out of the way to accept these invitations. Discussion of the subject of Mr. Diven's paper is now in order.

The President:—If there are no remarks to be made we will take up the next paper, which is, "Flushing Street Mains" by H. W. Ayres.

FLUSHING STREET MAINS.

In many places water consumers are afflicted at certain times in the year with impure and offensive water. In some cases this is directly due to ignorance or lack of care of the managers of the system; in others, strenuous and apparently intelligent management on the part of those in charge fails to produce entirely satisfactory results.

When the cause of the difficulty occurs in the source of supply as a tangible existence, we have various adequate means of controlling it and sending the water pure and sparkling into the mains: that is, provided we can control legally our source of supply, and meet the expense of radical remedy. However, it often happens that when the water at the intake is free from all objectionable features, so far as we can determine by our senses, or even by analysis, it becomes, by the time it reaches the consumer, offensive in the extreme, both in appearance and taste, while the odor is beyond description.

The cause of this state of affairs is found to be in the stagnation of water in dead ends and hydrant branches, a slimy growth on the sides of the pipe, especially at the joints, and in desposits accumulated in depressions of the mains. The only remedy in such cases is a thorough cleaning of all mains, dead ends and hydrant branches.

The accumulation of animal and vegetable matter in the hydrant branches and dead ends is the principal source of trouble. Could these be kept clear, and the water flowing constantly through the mains, or enough to empty them all every few hours, we should have no trouble from impure water provided it was pure and wholesome at the intake, but as this is impossible, we must resort to some remedy for these injurious conditions, and the most practical of these is flushing.

Pipe flushing is practiced more or less, with more or less satisfactory results, by nearly all water companies; but for really efficient results, the pipe system must have been arranged with reference to such requirements—and this cannot always be conveniently done, especially in places where no sewerage system has yet been adopted.

For effectually flushing, the pipe system must be capable of division into districts, arranged so that each may be flushed with as little interference as possible with other districts, and taking its water from mains capable of furnishing water in quantities equal to, or greater, than the discharging capacity of the blow offs in the district.

The location of blow offs and their size, will depend upon the topographical situation, and the size of the mains, but should be such as to drain all pipes in the district, and to discharge as great a volume of water as possible, while yet leaving the pipes full during flushing, and lateral pipes must be so arranged as to feel the draft on mains with which they are connected; otherwise they are as bad as dead ends.

Where it is practicable to do so, many companies prefer to entirely empty the pipes of the district to be flushed, and allow them to remain so as long as possible, in order that any foreign substance may become dry, and be more easily detached. When as much time as possible has been given for this drying, the water is allowed to enter the pipes under full head, and coursing rapidly through them, is supposed not only to scour their sides, but to lift and carry with it, out through the open blow offs, any sediment or deposit that may have accumulated in depressions.

The principal objection to this plan is the time required, and consequent increased fire risks, and a lesser is, that it is often necessary to create a back current, so that any matter not entirely removed becomes for a time more objectionable than ever.

The more usual method where success is secured, is to flush without emptying the mains. In this case flushing should begin with the section nearest the source of supply, all dead ends and hydrants having been allowed to run under full head for a considerable time. These being then closed, and the blow offs opened, an amount of water equal to four or five times the capacity of the pipes is run off. After which.

there should be no further trouble from this section until a new growth or deposit forms.

In this manner the work is carried on, care being taken to flush only from clean to dirty pipes, until the whole system has been covered.

The best time for flushing will be found to be when there is a surplus of pure water at the intake, selecting, of course, such nights or days as show minimum consumption. The work should be prosecuted as rapidly as possible, but sufficient time must be given to insure good results, which depend largely on the capability of the pipe system for flushing, but more especially on the judgment and intelligence of the persons intrusted with its management. As a corollary to the proceeding I will add.

1st. Where the presence of fish is suspected in mains a preliminary blow-off flushing should be given.

2d. Service pipes should not be used while flushing is in progress.

3d. The main point is to get the most water through the mains in the shortest time, without reducing the pressure on them to zero.

4th. Flushing from hydrants cannot be depended on for satisfactory results.

Lastly, it may be well to add that the number and size of blow-offs may be readily calculated from tables of frictional head. Those furnished by Mr. George A. Ellis, member of this Association, with his explanation of their use, being well adapted for this purpose.

THE PRESIDENT:---Mr. Ayres paper is before you now for discussion, and I wish to say no one need be alarmed because of the motion as to limit of time; my watch goes slow and you will not be cut off to soon.

The next paper before us is that on "Increased Revenue from Private Sewerage" by Mr. C. N. Priddy.

SUGGESTIONS ON THE ADVANTAGES OF SEWERAGE TO WATER COMPANIES.

The condition of affairs that it is proposed to treat of in this communication, is that of a town or small city where a public supply of water has been provided, and no system of sewerage has been projected, and to advocate the construction of sewers for the primary purpose of the protection of public health, and also the more extensive use of the water supply.

The construction of water works, insuring a liberal and regular supply of water, admitting of its free use for the luxuries, as well as the mere necessities of domestic life, involves the establishment of sewerage works necessary to carry off that water after it has been used.

When the supply is procurable only by means of manual labor, from wells or underground cisterns, the amount used is only a small fraction of what is now considered necessary for domestic purposes, and the disposal of the soiled water has usually been by means of the most primitive methods—thrown on the ground, or deposited in cesspools—both depending upon percolation for its removal.

The open privy or cesspool is frequently only a hole in the ground, the sides and bottom being the natural earth, and the contents, of

course, rapidly permeate the surrounding soil, spreading the pollution in each case, year by year, over larger circles, until finally the soil becomes fully saturated with the sewage, which then oozes through and appears on the surface of the ground, and by evaporation poisons the air we breathe, and must depress the vitality of the people, and predispose them to the attacks of fatal epidemics. With the soil thus saturated with the impurities incident to human life, the rainfall enters at the surface, and passes downward, carrying the sewage with it, and, sooner or later, reaches the water of the wells from which the people receive their daily drink.

Any condition of affairs that is sufficiently favorable to produce foul water and foul air, will tend to develop that class of preventable diseases known as filth diseases, the most familiar in this country being diptheria, scarlet fever and typhoid fever.

An abundant water supply, however beneficial in providing potable water, only aggravates the evil, as with the increased facilities for drawing water in any desired quantity for household purposes, the consumption of water increases in a like degree, and soon necessitates a change in the method of its removal.

Under the assumption of a public water supply, it is wholly unnecessary to investigate any other system of sewage removal but the water-carriage system. This system, as the name implies, depends upon the transporting properties of water for the removal of sewage, and is the best possible method, based upon the fact that it is the only system by which the rapid and automatic removal from the buildings, before decomposition sets in, of all the liquid and semi-liquid matter capable of being carried by water, can be obtained. This requires a properly constructed system of pipes and sewers, beneath the surface of the ground, to convey by gravitation all sewage to an outlet beyond the limits of the town.

It is believed by the author that where private corporations have control of the water supply, and the use of the water is rapidly extended, thus tending to produce an unsanitary condition in the town, they should be the first to initiate and agitate the necessity for a system of sewerage.

It is not intended to enter into a discussion regarding the system of sewerage which should be adopted, as that requires a special survey, examination and study of all the conditions incident to the particular place; but, for the extension of an existing system, and the construction of private drains, the sytem of small pipe sewers is earnestly advocated.

There being no discussion of the foregoing paper the President announced "Use of Liquid and Gaseous Fuels" by Mr. L. H. Gardner.

THE USE OF LIQUID AND GASEOUS FUELS.

I preface this paper by saying that this subject was assigned to me, I presume, because I betrayed an interest in it at our last meeting as an enquirer; and not because of any technical knowledge I possess concerning it. It has never been a habit of my life to shirk a duty. In performances of the duty now in hand I can only offer you the result of the work of an editor, or compiler of information and opinions kindly

placed at my service by friends, and gathered otherwise, and here bound into a rough fagot which, if your patience serves, you may take apart if it so please you.

In the announcement of this topic, the first thought of the hearer or reader turns naturally to Petroleum, and it is almost of necessity that this paper should most largely deal with it as the most prominent of of gaseous or liquid fuels.

What is Petroleum? The scientists cannot agree upon an exhaustive descriptive reply. It is natural hydrocarbon oil, and perhaps as near an analysis as is possible may be,

Carbon	84,
Hydrogen	14,
Oxygen	2, —100.

Popularly speaking, it has been in use, one way and another, for about forty [40] years. About that time has elapsed since scientific men first considered and studied the character of a dark oily fluid which trickled from some seams in an English coal mine. In the intervening time it has been utilized in chemistry and the arts to an extent challenging belief, and demanding a constantly increasing scientific nomenclature, as its uses have been adapted or expounded.

The abundance of its supply has, within the past twenty years, led to efforts for its successful use as a fuel, but the original methods have not been materially improved upon.

The romance of the story of coal and of petroleum (if we choose to consider the two as of close kin) is exceedingly attractive, and one which I would like to follow. My assigned subject however, instructs me to speak only in a utilitarian way, and vulgarly and practically to consider fuels.

At the last meeting of this Association, held in Cleveland, Ohio, two water departments reported experiments with crude oil. Mr. Gerecke, of Chicago, while notprepared with details, reported adversely, and in favor of coal. His later detailed report as printed in proceedings, confirms the statements he made from memory on the six months experiment in the use of oil in the Chicago Water Department. He says however, that the possible saving of labor and in repairs, by the use of oil, do not enter into his statement.

The other Water Department to which I have alluded, is that of Cleveland, Ohio. Mr. Whitelaw, Superintendent of that City Department, reported at our last meeting, an extraordinary evaporation by oil fuel which has been quoted and widely circulated by the Standard Oil Company. I have asked Mr. Whitelaw for the comparison *in dollars and cents* between the result of coal and oil fuel. He kindly gives me the following:

"The following calculations show the relative value of coal and petroleum as fuel for making steam as determined by trial with oil at the Water Works pumping station on Division St., beginning at 1.45 P. M Sept 30th and terminating at 7.45 P. M. Oct. 2, being 54 hours, or $2\frac{1}{4}$ days.

COAL FUEL.

Coal Consumed: Average for 1886, ... 3000 lbs. per M. G. $33\frac{3}{4}$ tons at $1.35	$45.56
Labor, one fireman, 54 hours at 23 ct	12.42
Coal Wheelers, $2\frac{1}{4}$ days at $1.66\frac{2}{3}$	3.75
Hauling Ashes, 1 day	2.75
Cost of pumping $22\frac{1}{2}$ million gallons	$64.48

Oil Consumed, 6131 Gals. at 1¼ct	$76.64
Labor, one man, half of 54 hours-27 hours at 18⅓ct	4.95
Cost of pumping 22½ million gallons	$81.59.
Difference in 54 hours or 2¼ days	$17.11.
Difference per day	$7.60
" one year for one battery of boilers	$2274.00
" per million gallons	.75c
" one year, pumping 20 millions gallons per day	$5475.00

In this connection it is suggestive that Chicago and Cleveland enjoy unusual advantages in the matter of practical proximity to both coal and oil fields.

It is claimed by the friends of crude oil that three barrels of 42 gallons each, equal and slightly exceed the heating capacity of one ton of good coal. This claim is confirmed by several large manufacturing establishments. This conceded, the average steam user has only to consult his local coal market in the light of competition. In adopting crude oil he may, under average conditions, and at cost for cost, in the light of the reports I have read, gain a saving of the labor of firemen or stokers. I cannot go so far as to include cleanliness, for I have not seen, nor have I heard of a fire room where oil is used, that is either clean or sweet smelling. On the contrary, waste oil is everywhere about such furnaces, and the neighborhood is perfumed from early morn to dewy eve, and until morning comes again, and not only with this, but with the language of denunciation in the vicinity, which hath a sulphurous flavor and which doth not savor of piety.

A large manufacturing establishment in New Orleans, some time ago, attempted the use of crude oil as a fuel. At about the same time a newly married couple in whom I am interested—a lusty youth and a charming bride, moved into pretty quarters in the immediate vicinity. Almost at once upon their settlement, happiness seemed to fade and vanish from the new home, and as months rolled by, hope seemed to wither like an Autumn leaf upon a deciduous bough. Unable to control or forbid the use of the villainous oil, whose fumes poisoned the air, a few friends procured the passage of a City Ordinance which forbids the escaping gases to float over the little home to which I have alluded. As a result, happiness shines once more upon the young household, and hope swells—but pardon me; I am wandering from my subject.

While upon the subject of smell, let me say that some claim it is due to leakage in the storage tanks or in conveying pipes. Others claim it due to imperfect combustion. I incline to the latter view although the London Warehouse Company report a heavy percentage of loss by evaporation through the wood of the barrels. Accomplishment of perfect combustion is not dependent upon any special form of burner, nor to atomizing preferably by steam or by air. But the air and the steam systems each have their advocates and supporters, and oppose each other. This desirable perfect combustion is dependent upon physical laws in supplying the necessary elements requisite for the purpose, and is a subject now occupying the attention of many students and inventors. It is admitted that the appliances now in use for burning oil have, to say the least, not reached the limit of perfection, or that under equal conditions oil can everywhere compete with coal. Unfettered by "Trusts" it might perhaps do so.

I have visited many Water Works plants and large manufacturies during the last few years, and have been struck by the careless handling of coal to the furnace;—otherwise stated, the reckless firing and waste of fuel. Now, under such circumstances, any attempt at improvement or economy, whether in furnaces or in grate bars, or in change of fuel, is hedged about with a carefulness in trial which did not characterize the pre-existing conditions or practice. That carefulness goes always to the credit of the new system.

My own judgment is, that a good article of coal, handled by trained firemen held responsible under proper rules, with the checks of an automatic pressure guage, of the automatic register of a boiler feeder, and accurate measurement of coal to the boilers;—in other words, with a good system of record and a trusty engineer to keep the record, it can be demonstrated that in Water Works practices, coal is, to say the least, quite as economical a fuel as petroleum under existing conditions of competition.

I do not find that oil is anywhere used as a fuel simply by economical preference. I think I can discover special reasons why oil should be used under some circumstances rather than coal, even at superior cost. An extensive correspondence on the subject develops to my satisfaction that as a fuel for steam purposes only, the economies are liberally stated in the relative cost of the fuel and labor. Otherwise stated, oil may be preferable where intensity of heat and the entirely steady maintenance thereof, subject to quick control, is desirable.

This can be automatically achieved by the use of oil, and it is therefore commended to Electric Light plants, Gas Works, Iron and Steel Works, Glass Works, etc., very many of which establishments endorse the use of oil as preferable to coal. For instance, Maj. Castle, Supt. of the Barber Asphalt Paving Co. with several large plants in the United States, finds an economy in the use of oil amounting to over thirty per cent over coal. This economy is incidental to the character of the business. An accuracy in intensity and quick control of applied heat is essential, whether in treating the sand used or in the distillation of the crude asphalt. In using coal, fires often have to be drawn and furnace doors thrown open, and often without relief—entailing labor, loss of fuel, and the ruin of valuable material. Of course, he finds oil a more economical fuel than coal.

At the late meeting of the National Association of Brickmakers at Memphis, Tenn. Mr. S. P. Crafts read a paper from which I extract the following. After a comparison as between wood, coal, gas, and oil, and carefully considering them, he says:

"From this it seems that there is very little difference between the cost of coal and oil unless some other consideration intervenes. You may keep your bricks at a dull red for any length of time, and fail to burn them hard; but if you can in a shorter time, with oil, get the requisite temperature, then you do the work in less time and at a saving of fuel. It seems to me that in this shortening of time and saving thereby is the principal argument in favor of oil over coal."

Mr. Crafts in his paper further says that he does not think the same argument or economy will hold good when the two fuels are compared in use under boilers.

Further to illustrate the difference between steam users and the other consumers alluded to and the relative economies: In a discussion on the subject last fall in the Franklin Institute it was stated that a certain Philadelphia manufacturer had enjoyed the free use of gasoline for generating steam, from some pretroleum factory. Later, the manufacturer was asked to pay for it. After consideration, he decided

on grounds of economy to use coal at the market price rather than pay anything at all for gasoline.

In Pennsylvania, with oil at 30c. per barrel, it has been shown that it costs nearly fifty per cent more to move a train of cars 100 miles by means of oil than when burning coal. Coal and oil are equally accessible, and at the lowest prices in that State, and the great Pennsylvania Railway still burns coal.

The attention now being given to this subject throughout the country, is something wonderful. Hundreds of thousands of dollars have been spent by private parties in experiments, and patents are being continually applied for in this connection. Something like fifty burners are on the market, and with more to follow.

As to safety. It is claimed that the use of oil may be deemed entirely safe on land. Prominent insurance companies however are watching it jealously, and its delivery by gravity to the furnace is for the most part forbidden. In quarters of high authority it is denied that any explosion or conflagration has ever been consequent upon its use. The most notable case differing from this statement is the Steamer "Julia" disaster at San Francisco in the past year. She used oil for fuel. She was a large ferry boat of 407 net tonnage, owned by the Southern Pacific R. R. Co., plying between South Vallejo and Vallejo Junction. The boat was shattered from end to end by the explosion. Thirty-four persons were killed, and twenty-two more or less seriously injured. Only three persons on board escaped serious injury, and the financial loss was a quarter of a million dollars. The Coroner's jury censured the United States Inspector for allowing the use of oil as a fuel on vessels. This officer (H. S. Lubbock) reported to the United States Treasury Department that the disaster was caused by the explosion of gases which had accumulated in the fire box of one of the boilers. This report was followed by an order of the Treasury Department forbidding the use of Petroleum as a fuel for large boilers on steam vessels.

As to Supply. The limit of supply of oil is a question of some interest in this connection. This may be considered in the sense of the actual and of the possible. In this day of consolidated "trusts," we never actually know what either may be. Outside the American fields, think, if you please, of a Russian well spouting 2,750,000 gallons a day to a height of 224 feet and the owner of this well, instead of being enriched, becoming bankrupt by reason of the damage suits of his neighbors. The oil king could not store his oil but had to let it deluge and ruin the adjacent property. Three or four years ago, the excess of American production over consumption had accumulated to the extent of 39 million gallons, stored in tanks. The surplus production is now being reduced by some 10,000 barrels per day. The total yield is said to be something over 70,000 barrels a day. In Russia the average flow in the Baker region is 88,000 gallons per day. With increasing Railway facilities in Russia, it is possible that the Russian product will not only displace American oil in European markets, but even invade America in competition. It remains for American inventive genius to come to the aid of both producers and consumers in showing them, in the light of its present abundance, how oil may economically compete with coal as a fuel.

So far I have spoken only of gaseous fuel in connection with petroleum. Allusion to natural gas would not perhaps be strictly germane to the subject assigned to me: first, because the field of its uses is limited, and second, because the duration of its supply, at least in a competitive sense, is, in the minds of many scientists, problematical.

Among these is the eminent authority of Mr. Selwyn Taylor C. E. of Pittsburg. He favors me with the following:

"I would say the amount of gas produced within a radius of forty miles of Pittsburg is to-day not more than 60 per cent of that produced two years ago, while the number of producing districts is one third more, and the actual number of wells nearly twice as many. What I have said relates almost solely to our own district; but what is true of it will certainly apply to others. Our most eminent authority on such matters in Pennsylvania is perhaps Professor J. P. Lestly; State Geologist; who is firmly of opinion that the life of our natural gas supply is very limited.

"Crude petroleum is being used to a limited extent by the Penna. Central R. R., as a fuel, but with what economic results I cannot say. It has been used on only a few locomotives, and that for some time: and the fact that it has not been generally introduced is perhaps conclusive that nothing is to be gained over coal in using it as a fuel. It is a stereotyped expression with Pittsburgh people "We will never go back to coal;" but when you ask what will be used instead, the answer is, "We will make gas from oil or water." To accomplish this last result, the Electric Fuel Gas Co., of Pittsburgh, was established. Some of the best engineers and mechanics in the world have been engaged by them, and after years of labor, they appear no nearer the desired result than at the beginning."

The views of this gentleman are particularly interesting and valuable because, in addition to his scientific attainments he resides in, and is familiar with a region of country which, rather than any other, presents the economical merits of natural gas, petroleum and coal, upon a fair plane of competition. He is decidedly of the opinion "that with the enormous quantities of coal easily and cheaply produced, it will still be the fuel of at least the next century, although the method of converting that fuel to use as power will perhaps speedily change."

Following this suggestive expression of opinion, which is almost prophetic, I would say that there remains a most interesting field for invention and the application of gaseous fuel. I allude specially to the production of gas from coal, on private premises, and the use of that gas as a fuel.

In one large city of this country two extensive manufacturing establishments are using gas as a fuel, which gas is generated on their own premises from an inferior article of coal. So great is the economy developed, that the manager of one of these establishments told me that it amounted to over fifty per cent as against the best bituminous coal, and that a vein of natural gas, if known to underlie the plant, would not tempt him to tap it.

And yet neither of these large fuel consumers is ready unqualifiedly to endorse this fuel thus generated, for economical use under boilers and for the purpose of the generation of steam alone.

And yet I have reason to think and to believe that when slack coal can be bought at a trifling price, compared with the best quality of coal, it can be converted into gas by some simple process and so its entire value utilized as fuel. I incline to this as an economical alternative rather than the use of petroleum as now used.

So far, after a faithful study of all the accumulated data and information before me, and speaking to and in behalf of steam users, I incline to the belief that nothing as a fuel is to-day superior to first class bituminous coal. The Superintendent however, or the Chief Engineer, should see that the coal goes under the boilers in a proper manner. I would ask no larger fortune than one third of the present

waste of coal in connection with the Water Works Plants of the United States for one year.

MR. DIVEN:---While in Cleveland I had an opportunity to go through a large Oil Company's works, and I saw crude oil being burned there to a limited extent for fuel, perhaps in a half a dozen cases they were using crude oil, but at the pipe line pumping station they use coal entirely. Now, they have crude oil to give away, to throw away, it is waste, and yet they find coal cheaper to use.

MR. JONES:---Col. Gardner alluded to having seen gas made out of coal. He refers to the pipe manufacturing company of Shickle Harrison & Howard of St. Louis. I had occasion to investigate the matter to some extent. They propose when they perfect arrangements to manufacture the apparatus and make the application of it as a business, as a factor in their business. I do not know that I can explain the process better than to say that there is a large cylinder, perhaps twelve feet in diameter and about fourteen feet high. The coal is delivered at top which is closed with a conical shaped stopper from the under side by means of a chain: that stopper is lowered and the coal distributed evenly all around. From this the gas is made and forced out by means of a blow pipe into a furnace and carried immediately under their oven. They told me it made a saving of at least fifty per cent, and so anxious were we to have such an apparatus that I told them we would give them the chance to build four such plants for us when they were ready, but they are not ready yet: they are simply experimenting with it. A short time ago I stopped over to see it again and was told that they are making some progress, but it is so far from perfection in their own estimation they are not disposed to proceed with the work until they know more about it. It is a very interesting idea of first making gas out of coal and then using the gas for heating.

MR. DARLING: I would say that I have had no experience with oil or gas. We use in the east hard coal. as it is called, but it was my fortune on my journey here to drop off at Pittsburg and spend the day there out of curiosity to see this natural gas business. and I will assure you it was a curiosity to see it. There is a boiler room there containing a battery of eighteen horizontal boilers, having an eight inch pipe running along the face with connections, four and six inch, under each boiler. A gentleman was sitting at the door of the engine room with a small guage before him which indicated the

steam pressure, he had convenient to his hand a cord which was connected to the valve controlling the gas. There he sat as independently and deliberately as he could, quietly smoking his cigar, if he wanted to, with nothing to do except to pull the cord a little either way to regulate the steam. One of the most peculiar features of it was, there was not a man in the boiler room. It struck me as interesting from the fact that usually with such a long line of boilers you see quite a number of coal heavers. Of course, they expressed themselves as perfectly satisfied with the results received to the present time. It bids fair to extend into the future, but how long, is a matter to be decided. It is confined mostly to that section, and its utility will necessarily be circumscribed until new gas wells are found in other sections of the country. But it certainly was as interesting a thing as I have seen in quite a while, and I would simply say that if any of you visit that territory you will be amply repaid by going to see it.

Mr. Donahue: I understand Mr. Gardner to say that crude oil costs to pump 22,000,000 gallons of water at Cleveland $81.00 as against $64.00 for coal. I would like to ask him how much per bushel or ton that coal was and what price the oil was figured at. Of course, we are not all blessed with cheap coal.

Mr. Diven: Nor cheap oil either.

Mr. Gardner: Mr. Whitelaw reported the cost of his coal as $1.35 a ton, and oil 1¼ cents per gallon; the friends of crude oil claim that three barrels of 42 gallons each, equal and slightly exceed the heating capacity of one ton of good coal.

Mr. Diven: It would take $2.50 for coal as against the oil. Now, the question is how much you would save in labor.

A Member: It seems to me the wear and tear of the boiler ought to be taken into consideration; I have heard no statement of that fact yet. As far as I know the experiment has not been tried long enough to find that fact out but it seems to me that it would be important.

Mr. Diven: It is quite evident that the heat on the boiler would be better than with coal. In firing coal you are apt to run the steam up and down; you can't keep an even pressure. In Pittsburg, with natural gas they tell me, the steam pressure does not vary two pounds from one year's end to the other.

MR. RUSSELL: I have been looking into the question of oil and coal myself of late, and am much interested in the subject. As to making gas from coal and using it under the boilers I have been told that it gives a very good evaporation in some cases, but have not been able to learn whether we could get the same steaming capacity in the boiler as with the coal burning direct. I am very much inclined to think that if we are going to burn gas under the boiler we will have to use larger boilers. I am not prepared to state that positively until I have investigated further, but that is my opinion. It is shown in some experiments by French authorities that a gas flame will not *radiate* as large a *per centage* of its heat as a coal fire.* When you burn coal direct under the boiler you get a large *radiation* from the glowing coke, as is seen by comparing the evaporation per square foot of heating surface of fire box with that of flues. The histories of many *smoke consuming* devices bear witness that *radiation* is not to be shut off with impunity. I think you will find that gas will not do as much work as coal with the same boiler.

MR. OLIPHANT: In Widmar's mill they have been using oil for the last six months, and as our brother said, they were not sure about it---that is the capacity of oil and coal. They had nine boilers running with coal and they are doing the same work now with seven with oil: but the drawback to oil is its liability to explode. On the first two or three days run there was one of the boiler walls blown down by an explosion of the oil. That was caused by shutting the damper on the gases. But I think the paper that has been read is one of great importance to all individuals interested in steam, and it ought to be printed and a copy sent to each member of this association for their study after leaving here. It is a very valuable paper and contains a great deal of information of importance to all steam-users.

MR. SKINNER: Although I am not a member, I will take the liberty of stating one or two facts that may possibly be of interest. In 1884 or 1885 a pretty large plant was established at Montreal for manufacturing purposes. $450,000 was invested in heavy machinery driven by twenty-three or twenty-five individual engines. There were also three or four large furnaces for heating iron for welding. The fuel for all pur-

*Peclet's experiments show that a charcoal fire radiates 50 per cent. of the heat generated, while an oil flame gives off only 20 per cent. by radiation, 80 per cent. of the heat generated being carried off by the gaseous products of combustion.

poses of heating was supplied by gas manufactured from coal ---Nova Scotia slack; my impression is it costs $1.00 to $1.20 a ton; I am not prepared to say now much was used but it was very considerable. That process has been in use ever since. I saw the chief engineer a few days ago and he said it was still giving good satisfaction. One point that has not been mentioned, is that gas can be made from a very inferior quality of coal as well as from very fine slack, and in places where there is a great deal of slack it might be worth consideration on that account.

Mr. Darling: I understand we have a gentleman present who has used natural gas for two years, Mr. Hamilton, from whom we should be glad. to hear

Mr. Hamilton: Our experience with natural gas in the last two years has been very favorable. It is easier on the boilers and gives a very steady steam pressure. We use an automatic regulator, which regulates the amount of steam. The steam I do not suppose varies two pounds in twenty-four hours. Then, there is the absence of soot on the boiler, which I think makes it more effective; the boilers are perfectly clean ---not a particle of soot on any part of them.

Mr. Gardner: If the discussion is now closed I desire to say a word to the assembly. You must all have been struck and interested in the matter of citations of legal decisions which were given by the president this morning. In that connection I would say that two valuable and interesting papers were read by Mr. Denman at the Minneapolis meeting on the subject of the "Legal relations existing between Water Works companies and the consumer," and the subject "Is water property." Mr. Denman has been considerate enough to have these printed, and he has a number of surplus copies which he will be very glad, I am told, to give to any members of the association who may desire them and who will write to him asking for them I would advise you to do so for I do not know of any more valuable papers that have been presented before this association than these. I am corrected by Mr. Denman, who says this edition was printed by the association.

The Secretary: I am in receipt of a telegram from Mr. George H. Chandler stating that the death of his wife causes his absence.

Mr. Gardner: I dislike to seem to take up so much of the time of the association, but a gentleman has brought to my

recollection a matter which the secretary has asked me to bring before you. It is this: Are the papers read at our annual meetings to be given out for publication before our proceedings are issued, or not? What is the policy that should govern us in the matter? There are two sides to the question. I have at this meeting given a copy of my paper to one of the papers represented here, and I was flattered by the request. It has been done before. The practice may operate to our advantage and it may operate to our disadvantage, and we should know what rule should govern members in the matter. I should like to have an expression of opinion on the subject so that writers as well as the secretary may be guided hereafter. In order to raise the point for debate I move that the matter be left to the discretion of the secretary.

Mr. Donhaue: I don't know whether I understood Mr. Gardner correctly. Does he refer to having these papers printed on separate sheets or reported in the local papers?

Mr Gardner: I mean the policy or propriety of furnishing the technical journals with copies of the papers read before our association in advance of the publication of our proceedings. I have no earthly objection to it, and I have no word to say for or against it; I simply wish to know what shall govern the association. Does any one know what rule governs the Society of Civil Engineers in this respect?

Mr. Cameron: I think inasmuch as the reporters are here and can take steps to get these papers, there is no reason why they should not have them first as last: in any event they can get them during the session of this meeting, and besides we are very much interested in reading these papers long before they are published in the report of the association. I am in favor of having these papers given us as soon as possible and if we can get them through the daily papers or periodicals I think they ought to have them.

The Secretary: I desire to say that as far as my connection with this question is concerned I have always gone on the broad theory that this association was organized as a public benefactor, as a benefit to ourselves and for the benefit of our fellow water works superintendents. With that idea in view I have always in the past, where it was asked, furnished the papers to the technical journals. On one or two occasions that course has been rather questioned and I requested Mr. Gardner to have it decided. It has been left to me for

nine years, but I prefer to do it hereafter under the sanction of the association, if it shall see fit.

MR. SKINNER: In regard to Mr. Gardner's question as to the custom prevailing in the Civil Engineers Society I can say positively that the technical journals are permitted to make the fullest possible abstracts. Any one can attend the meetings and make as full reports as they choose. The secretary of the society invariably presents to any accredited technical journal who requests it the paper, or copy of it, or facilities for making extracts as completely as may be; as long as it is accurately abbreviated it is all right.

MR. DIVEN: I understand Mr. Gardner's motion to be to leave it to the discretion of the secretary whether the papers be given out or not. I second that motion.

MR. CAMERON: I offer an amendment to that resolution, that the secretary be instructed to let these journal have them whenever requested.

MR. DONAHUE: I agree with Mr. Cameron; I think it is to our advantage to have these reports published as soon as possible, and if the papers are courteous enough to take notice of them it is a benefit to us all because we would like to look over these papers as soon after the convention as possible. When we get to read them in the regular report our attention is likely to be distracted by other things and we lose certain points. I do not think it would lessen our interest in the annual report because we will always have that report to refer to, and I think if the newspapers are courteous enough to publish the reports without any expense to the association we ought to feel very much gratified and under obligations to them.

THE PRESIDENT: The motion as amended is that the secretary be directed to furnish copies of these papers to representatives of the various scientific papers.

MR. GARDNER: Who is to pay the expense of this work?

MR. CAMERON: The custom has been for the gentlemen who read papers to furnish extra copies to the press, so there will be no expense. (laughter).

The motion as amended being put, was carried.

THE PRESIDENT: We have some little time left before the hour of adjournment, and it has been suggested that the ques-

tion box be opened. If any of you have interesting questions you would like to discuss present them to the secretary.

THE SECRETARY: I have one question here that has been presented: "How do you stop the waste of water?"

A MEMBER: Shut the water off. (laughter).

THE SECRETARY: If no one else will answer the question, I will say as one reply that I put in thirty-five meters last month to stop part of it.

MR. PRIDDY: In our case the first time a man is caught wasting water he is fined two dollars, the next time he is fined five dollars, and for the third offence of that kind the water is shut off; then he will be apt to remember it.

A MEMBER: I would like to ask the gentleman whether his works are under the control of the city or a private company?

MR. PRIDDY: A private company.

MR. CAMERON: I would like to explain to the members present that I am the gentleman who asked the question how to stop the waste of water, and I know that out of so many intelligent and experienced superintendents, some of you have found a means of stopping the waste of water, not as suggested by Mr. Diven, with a double-barrelled shot gun, but in a manner equitable and legal. Of course, at conventions we know how to stop the waste of water (laughter), but I mean when we get home and hard at work.

MR. DONAHUE: I dislike to make myself too prominent by jumping up so often, but this is a subject that interests me, and I guess interests a great many of you. There is certainly one true way of stopping the waste of water, by meters; but sometimes we do not place meters on all our consumers. Now, where we have consumers who waste water, where they have an unlimited use of it, it is all right for some water works men to say, "We will fine them two dollars and then five dollars and then shut the water off." That man is blessed no doubt with a very good charter or ordinance back of him, but in a case where the water works are owned by a private company your charter don't cover every point and you have a city council pumping you pretty hard, it is a difficult question to solve as to how to stop the waste of water. We have had considerable experience in it. We have tried every known method outside of metering. With a small con-

sumer I hardly think it pays to put in a meter, but at the same time he can waste an unlimited amount of water. We have met with the most success by having the inspector go to the consumer and talk to him in a reasonable way; it takes a little time but it will win in the long run. Talk to him quietly, tell him you have given him a low rate and that you trust to his honesty, that you will supply him all the water he can use but request him not to waste any, and it is only in extreme cases where you will find a stubborn man that will not abide by the rules and help you out. If a man persists and will not mind you, then shut the water off. It is quite a difficult thing to make a rule, because if you make a rule for a man he is sure to try to break it, but after a little reasonable talk I think it can be stopped in cases of small consumers. With large consumers we certainly need meters. I am satisfied now of that from ouy own experience. But what would suit us probably would not do in another place. I have a few details for my own reference and not gotten up for this meeting at all. I find in the year 1881-2 our net revenue was decreased by increased operating expenses on account of the terrible waste of water and increased pumpage. We have overcome that, however and last year we supplied over a hundred new consumers over the previous year and some of them very large consumers, and yet pumped less than the previous year by 90,000,000 gallons, and our receipts increased I think $3,500 or thereabouts. We did it by taking the time to talk to consumers.

Mr. Martine:—I had one case where a party was getting water for $25.00 per annum and wasted a great deal of it. I proposed to them to put in a meter; they said they would be glad from the fact that they would save expense. After the meter had been in a fortnight I read it and they had used $90,00 worth at the rate we were selling it. I told them of it, and the month after that they used $15,00 worth.

Mr. Diven:—I think a large part of the waste is due to defective plumbing; probably more in the water closet than anywhere else, and probably the consumer don't know it. So Mr. Donahue's argument would not do.

Mr. Priddy:—We cannot use meters on account of the frost. I have tried Mr. Donahue's style of argument to my heart's content, and I find the best mode of stopping the willful waste of water is by imposing a fine, my experience has been if you fine a man all his neighbors will know it and

they will take the hint, and it has saved me more water than any other mode I could devise.

THE PRESIDENT:—The time has expired for the discussion of this question. Eternal vigilance is the price of water and also for the stopping of wasting of water. We will take up the next question.

THE SECRETARY:—I had this question handed to me by a gentleman before dinner, I don't think he is in the room; I will however read the question: "Is steel of ¼ inch thickness sufficiently heavy for the shell of boilers 60 inch diameter 18 feet long carrying an average steam pressure of 75 to 80 pounds?"

MR. RUSSELL:—What is the tensile strength?

THE SECRETARY:—I suppose ordinary 60,000 to 70,000. steel.

MR. RUSSELL:—That would make quite a difference.

THE SECRETARY:—I know it would; assume ordinary 60,000

MR. RUSSELL:—The strength of Steel will run from 65,000 to 70,000; it makes quite a marked difference. I should say with good steel, 65,000 pounds, yes.

THE SECRETARY:—The point desired to be brought out as I understand is whether it is policy to use light shells.

MR. DIVEN:—It would depend on the pressure you wanted to carry; I think the lightest shell that would stand the pressure would be preferrable. I think there is a Government rule about that.

THE PRESIDENT:—The next paper before the association is "Pressure Regulators for Water Works" by William Ryle.

PRESSURE REGULATORS FOR WATER MAINS.

A Perfect Pressure Regulator must be all its name implies, automatic in action, pressure controlled from low service side, and open and close without water hammer.

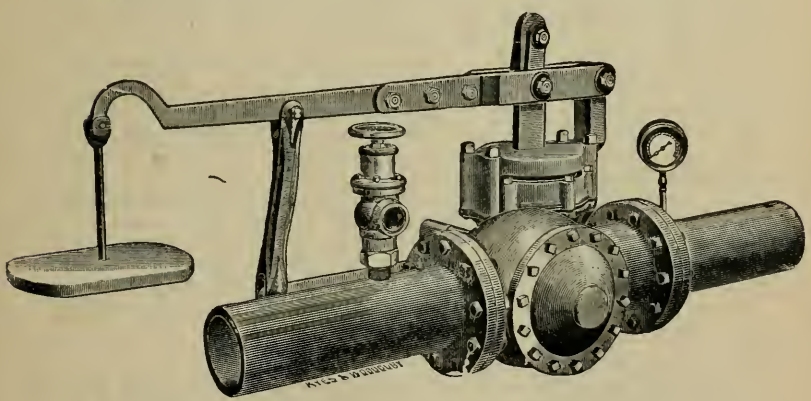
The first successful ones, which I can find were two twelve inch placed at Worcester, Massachusetts, in 1872 and were used continuously until 1883, and their use then discontinued because an additional low service was introduced into that city. Pressure on high side, 160 pounds: low side, 70 pounds. Mr. John G. Brady.

water commissioner, reports; "done the work uniformly and entirely satisfactory, and with but slight variation in pressure on low service side," Regulator made by the Union Meter Company, Worcester, Massachusetts.

The first engineer to apply Pressure Regulators to an entire water works system was S. E. Babcock, Chief Engineer of the Little Falls, New York, water works, and were applied at Amsterdam, N. Y. A. H. DeGraff, Superintendent and Engineer, reports: "We have six Pressure Regulating Valves in use, two ten inch, two eight inch, and two six inch; four of these valves have been in use about seven years, one for three years, and one for one year. They have given entire satisfaction and hold the pressure at about 70 pounds in the business part of the city, the pressure on upper side is about 90 pounds, and in lower about 30 pounds." Regulators made by Ross Valve Company, Troy, New York.

Mr. W. H. Williams, Superintendent of the Augusta Water Company, Augusta, Maine, reports: "Have an automatic valve to regulate the flow of water into a small reservoir, which supplies the Maine Insane Asylum. This valve is on our six inch main, the presssure, high side, 60 pounds; on low side, 37 pounds. It has been in use two years and gives good satisfaction."

At St. Albans, Vermont, Mr. Marshall Mason, Superintendent, reports: "Have an eight inch Regulator placed to reduce water hammer from hydraulic crane at the Rolling Mill, working the power by three inch gate; pressure on high side, 112 pounds; low side, 85 pounds, consider it an effective economical machine. It relieved our pipes at once, working like a charm." Made by Union Meter Company, Worcester, Massachusetts.



At Plattsburg, New York, D. C. Boyton, Superintendent, reports: "Have a ten inch regulator, has been in use nine years, and has always proved satisfactory." Made by Union Meter Company, Worcester, Massachusetts.

At Rockland, Me., Superintendent, J. W. Crocker reports: "Have ten inch regulator located at point between the reservoir and lake; being 171 feet below high water mark in the lake and 65 feet below high

water mark in the reservoir. It is set to keep the water at high water mark in the reservoir, *viz*; 224 feet above the sill front of their office. Been in use three years and up to this time it has worked to our satisfaction." Made by Union Meter Company, Worcester, Massachusetts.

Mr. S. E. Babcock, Chief Engineer at Little Falls, New York reports: "Have three in use, twelve inch; 120 pounds high side; 20 pounds low side. I find them very raliable." Made by Ross Valve Company, Troy, New York.

E. R. Payson of Portland Water Company, Portland, Maine, reports: "We have connected with our works two twelve inch self regulating pressure valves, both made by the Union Water Meter Company, of Worcester, Massachusetts.

The first was set in 1882 at our reservoir, it opens when pressure reaches twenty-five pounds and lets the water into the reservoir, if the pressure falls below five pounds it allows the water to flow from the reservoir into the main pipes.

The second regulator was set in 1888, connecting our high and low service systems, when the pressure is over 60 pounds on the high service side, it opens and allows the water to flow into the low service, if the pressure should fall below 40 pounds on the high service side, it opens from the low service side and allows the water to flow from that side as far as it will supply the high service side.

Both of these valves do all that they were guaranteed to do, and we are perfectly satisfied with them in every respect, they are always to be depended upon, and we now consider them indispensable in connection with our works.

At Worcester, New York, they have two regulators, eight inch. 140 pounds, high side, and 85 pounds, low side, and have been in satisfactory use two years. Made by Ross Valve Company, Troy, New York.

At Paterson New Jersey, we have one sixteen inch regulator made by the Union Meter Company, of Worcester Massachusetts, the largest one in service up to this date; 37 pounds on low service side and 50 pounds on high service side and was placed in 1885, and up to this time it has worked to our entire satisfaction. It is used to back all water possible in the storage reservoir, which is filled by steam power and located in the western part of the city, and pass through it only the defiecincy not supplied from the reservoir in the northern part of the city, and filled by water power.

With our experience of this one, we feel safe in advising any one wishing one of the larger size, to use them in a number of twelve or sixteen inch regulators to gain the desired service, instead of trying to have one made larger than sixteen inches.

These valuable appliances make it possable to so reduce an extra high pressure to a lower one, with certainty of the supplying of a small amount of water, or all the area of the regulator, without changing the pressure of the low side, and without an intermediate reservoir.

There being no discussion on the subject of the paper, on motion, the meeting adjourned until eight o'clock p. m.

EVENING SESSION, WEDNESDAY, APRIL 16, 1889.

Meeting called to order by President Denman at 8 o'clock.

THE PRESIDENT:—While waiting for other busiuess, there may be some gentleman present who have points they would like to raise for the purpose of getting information, and there are men here experienced in the water works business who may be able to help such. I hope any gentleman will feel free to occupy the floor in his own behalf.

MR. RICHARDS:—I would like to ask the active members of the association if any of them pump water or furnish it at so low a rate that it could be used by a compound condensing engine against coal at two dollars a ton.

MR. DARLING:—If I understand the gentleman, he wants to know whether, when so large a quantity of water is used as is necessary for the coudensation of steam, you could afford to sell it at such a price as would allow its use for that purpose. I had such an application last week from a concern that wanted eight thousands gallons a day for condensing purposes. That quantity under our rates would cost them six cents a thousand gallons and the question is whether they could afford it, they are now figuring it out. They have an ordinary factory engine, and this water is to be used for condensing the steam and returning it back to the boiler.

MR. DIVEN:—You mean you furnish the water at six cents a thousand gallons.

MR. DARLING:—Yes, for anything over one-hundred thousands gallons per day.

THE SECRETARY:—I have here a letter from the Secretary of the New England Water Works Association which by permission I will read:

NEW ENGLAND WATER WORKS ASSOCIATION,

OFFICE OF THE SECRETARY.

NEW BEDFORD, MASS., April 13th, 1889.

J. H. DECKER, ESQ.,

SECRETARY AMERICAN WATER WORKS ASSOCIATION.

DEAR SIR:—Your kind invitation to the members of this asssociation, to meet with the American Association at the Louisville convention, was presented at the last meeting.

This Association will be represented at your convention, by our President, Hiram Nevons, of Cambridge, Mass., who will testify to the fraternal interest which we have in your most excellent organization, and in our appreciation of the splendid work which you are accomplishing.

Please extend a most cordial invitation to such of your members as can so arrange to meet with us at Fall River on the occasion of our annual convention on June 12th, 13th and 14th.

Personally I regret my inability to be present, but circumstances forbid.

Trusting that your sessions may prove most interesting and exceedingly profitable, I remain Yours sincerely,

R. C. P. Coggeshall,
Secretary.

THE PRESIDENT:—The letter extends an invitation to attend the Fall River meeting June 12th to 14th. Gentlemen, what will you do with the letter?

It was thereupon moved and seconded that the invitation be accepted with thanks. Carried.

THE PRESIDENT:—We will take up the regular order of business, which is a paper by Mr. Darling, "Should a city or town provide meters at its own cost?"

"SHOULD A CITY OR TOWN PROVIDE METERS AT ITS OWN COST TO CONSUMERS OF WATER?"

Mr. President and Gentlemen of the American Water Works Association:

THE question to which my attention is drawn is one of various opinions, therefore I can only speak of the experience that has come under my personal observation. At the completion of our works in September, 1879, it was voted that hereafter meters be put in at the expense of the town in all cases where the consumer had over two faucets except where a consumer desired a larger size than the Commissioners deemed necessary, in which case the price of an ordinary sized meter would be deducted and the balance of cost of the larger meter be paid by the consumer. I believe Pawtuket was the first town to adopt that system in this country. A division of the Pawtucket works known as the Central Falls Fire District adopted the same rules the following year. This ruling seems to have met with general favor, and the number of meter takers has rapidly increased since. Our minimum price is $10.00 in advance for all meters, allowing them to use 33,333 gallons, thus enabling the mechanic or laboring man who owns a little home, or the capitalist who builds and rents tenements, to have all the luxuries of the rich man in his mansion in the use of water, and the result is that the average amount received is about $16.00 a year for that class of meters, and under that system the works became popular with that class of consumers. I therefore maintain that it is

desirable for any city or town to furnish the aforesaid parties on as reasonable terms as can be done, because it stimulates them to cleanliness, (which is next to godliness,) and the sanitary results speak volumes in defense. Of course I can see that where private corporations have charge of the city or town, they have no particular interest in the aforesaid results, as the representatives of the same have expressed themselves in previous discussions, and yet I am led to believe that the revenue received from the small takrs is of minor importance to that of the manufactories, mechanical or hydrant rental, which is received by all private corporations. You all know that if any corporation had to depend entirely on family supply for revenue, they would not invest their money in that town or city. I therefore come to the conclusion that the small difference received between faucet and meter rates is not paramount to the good results which will be produced, and the good will of the citizens. Corporations know the the animosity that always exists against them in a city or town where they do not show a liberal disposition.

I am reminded that at my early connection with water works I had occasion to advocate the use of meters and the supplying of the same by the city or town; and let me say here I mean only the family meter, or its equivalent, when larger ones are required.

In discussing the subject with some superintendents, I was informed that they did not care how much water was used, they could afford to pump it, as their coal only cost $2.50 per ton delivered. I thought to myself what will be the capacity of their pumping plant within a few years at that rate. The same parties have put in larger engines since, and now recommend more or putting on meters and making a house to house inspection to stop the waste. Another Superintendent said he did not care how much water was wasted, as he had just as soon have it run through the faucets as over the dam. He had the gravity plan and quite a long distance to convey his water. The result I predicted was he would lose the head by the friction on the pipe, which has been partially demonstrated since. I might enumerate many such incidents, but time forbids. I maintain that you cannot afford to waste water under any circumstances, and especially where you have to pump it.

Now, what is the remedy for stopping the waste? I say most emphatically, the meter system. My experience is that we receive additional revenue enough "by the use of meters," from waste caused by poor plumbing, leaking in water-closets, or the cock and ball in tanks, and other ways that are unknown, to pay for *all* new meters supplied, and I believe that the experience of others will indorse my statement. By referring to a paper read at Cincinnati, April 16th, 1884, on the discussion of the subject of meters, there were different experiences related which have a bearing on this subject. There is but one situation that I can see where meters are useless, and that is where you have an unlimited supply on the gravity plan, and that situated close to your city or town where the expense will be comparatively small to put in large mains enough to protect the friction on the pipe, with sewerage sufficient to deliver the same; then you could allow them to use and waste all the water they wanted to. I sometimes think I should like to see one situation, if it could be found, where a works could be established and allow the many people that can be found in all cities, to move there and enjoy their wasteful propensities to the height of their ambition. What a record we should see, and I believe that the curiosity to know what the result was, would induce the superintendents of the country to *chip in* and procure a meter to be placed on the main supply.

The waste of water is getting to be a serious question, and especially where it has to be pumped into reservoirs and settled and then repumped into the city, or where they have an unlimited supply and are allowing an unrestricted use of water.

I believe that it costs less to supply and maintain meters than it does to erect pumping engines and storage reservoirs. The cost of coal, while it enters into the expense account, has its bearing where water is legitimately used and paid for, but where is wasted it has a further value, as it caries with it the cost of machinery, stations, pipe lines and new sources of supply, besides the wear and tear, the continuous expense of pumping, and the pay of the engineers and firemen. I would like to ask the experience of superintendents what the effect of extreme cold weather has upon the daily consumption of water. I have about 2000 services unmetered, with from one to three faucets. Now my experience is, let it come cold nights and we are obliged to pump 500,000 gallons more per day to supply the waste from these services alone, for the other ones are metered and we receive pay for the water. Please make a comparative estimate from your own situation.

We find another trouble with unmetered services: the faucets will leak and remain so until the inspector comes around, then they will be stopped, but where the meter is placed they do not wait for the inspector, because it costs money. Another result we get is, where we find the services are *excessively* used, where there are only two faucets, we put a meter on and invariably we receive a revenue over and above the faucets rates, which will pay for the meter, sometimes the first year and sometimes in two years, but invariabley we get paid for the meter. And yet the person is perfectly satisfied when you show him he is necessairly using the water and at the rate of one cent per barrel. It must be borne in mind that the unmetered service *can* and *does* waste more than the metered, even where they are willing to pay for the waste, as they have no restriction except the inspection. The rules may provide for penalties, but what do consumers care when the inspector's back is turned, and what do they care whether the faucet is shut or not, it costs no more. Show me a city or town where they do not use meters "with but few exceptions, and there they have a systematic house to house inspection," and I will show you pumping plants in excess of what ought to be, and a per capita of consumption that will astonish you. I do not pretend to say that the meter will apply to a large majority.

The meter system produces good rssults, as it shows to each and every one that they are used alike, and gives them equal privileges at the same cost. In fact they pay their bills seemingly with pleasure and I may add that during the collections of the past ten years, and receiving over $600,000. I have never had a single one come into the office with a grievance but what, after an explanation, left apparently satisfied and paid his bill.

In regard to the repairs of meters I may say we remain practically with the same proportional resnlts as in my statement made in 1884.

As a result of the meter system in Pawtucket, in 1879 our works cost over $600,000, and the revenue was $16,000 for that year. It was thought by many that we could never pay the interest on the debt, but in 1882 the revenue was $47,000, and the Commissioners reported they were able to pay all interest and maintenance accounts. Since 1879 we have increased the debt from year to year by building necessary dams, reservoirs and pumping stations, so that it now amounts to about $1,550,000, and we have paid all maintenance and interest accounts on

the same, and passed into the sinking fund and construction account $44,000 besides. Our works are now fitted to do the necessary work for many years without any large expenditure of money, and an increase of revenue is sure to follow.

You must also remember that our rates are as low or lower than the majority of other water works, under similar situations. Our revenue for the past year was $95,000, using less than 4,000,000 gallons per day, and supplying a population of about 55,000, with a consumption of 65 per cent for purposes other than family use.

I desire to say a few words in regard to the correctness of meters. We all know that the consumers of water, in case their bills overrun, doubt the meter's correctness. Now in an experience of ten years I have never seen an instance where I had occasion to think that the meter had registered against the consumer, but on the other hand I know that there are circumstances where the meter will pass water and not register. This subject was very generally discussed in 1884 at Cincinnati, and our late associate, Mr. W. C. Stripe, offered the following resolution:

"*Resolved*, That it is the opinion of this Association that water meters do measure water generally correct, and that where they make mistakes it is invariably in favor of the consumer."

Since that time I have had experiences which verify that opinon and I make it a rule that where the consumer doubts the correctness of his meter he shall devote his personal attention to seeing the meter put under test, and varify the correctness himself. I have never had a case but what he went away perfectly satisfied that the meter could not register against him, and I may say that quite a number have availed themselves of the opportunity.

In conclusion, I would say that from my experience of ten years in the use of meters in all forms (to which I attribute a large proportion of our success,) I do believe that it is advisable for cities, towns, or corporations, as a rule to furnish and maintain what would be called a family meter at their expense (except in case of frost or abuse) and charge it to the construction or maintenance account.

Thanking you for your attention, I submit the foregoing statements to you for criticism or endorsement

MR. GARDNER:—I had hoped to meet our friend Mr. Benzenburg of Milwaukee. I wrote him a personal letter begging him to come. I knew Mr. Darling would write as he has written and express the sentiments he has expressed Mr. Benzenburg takes the opposite view and half way promised to give us a paper on the opposite side. He writes me regretting his inability to write the paper, and says, "Our department merely places the meters and requires the owners of the premises to purchase the meters and have the necessary plumbing done at their own expense. The city furnishes the meters at the minimum cost. We take this manner because we feel the consumer will be more carful of the meter than if the city owned it. We have come to this conclusion by our experience in the past. The attachment of a large number of meters would involve a considerable sum of money to the city, whereas to the individual it involves a small sum.

I will enclose our regulations and further information on the subject will be given at any time." And the substance of this is embraced in the regulations. I would be glad to have this subject discussed for I am looking for light on the subject. I have no opinion of my own to express.

MR. DIVEN:—I think it important that the water works should have charge of the meters. If the meter belongs to the consumer he would naturally object to our dictating to him what meter he should buy. I think we all know that some meters are not what they should be. It is important too. that the water department have charge of the repairs of the meter. Here is another difficulty: Can we assume the right to do the repairing of another mans meter, or say when it shall be repaired? He might say the meter was doing the work all right when it may be giving him ten or twelve gallons per cubic foot. If the consumer claims the right to take it to the office or send it to the shop then we must shut the water off or let him have water without measurement. On the other hand if we own the meters. we can put in another one. register it and charge it on the books. while if we undertook to put another meter in place of his own, he would be apt to make a row and say. "Why this meter is not as good as mine and I won't have it."

MR. RICHARDS:—I can give a little experience in meters but I am on the other side. We require everybody to put in meters. A man that wants water to lay brick must buy a meter. My brother Diven says it would get up a row if you should tell him he had to have a meter. Who ever heard tell of a water works superintendent living if he didn't live in a row? (laughter). I have been living in a row for fourteen year, the only relief I get is when I come to these conventions. (laughter). We have 2186 meters, and have but very little trouble. The people have to be educated up to this thing. They think the water meter belongs to them, which it does, and when there is anything wrong we send them a little note that their water meter is out of order. But of course those of you operating private water works have experience a little different from that. When the works belong to the city, the city can do pretty much as it pleases.

MR. MILNER:—How often do you read them?

MR. RICHARDS:—Once a month.

MR. MILNER:—You collect monthly?

MR. RICHARDS:—Yes, at the end of the month. We give a consumer ten days to pay his bill; at the expiration of ten days if it is not paid the water is shut off.

MR. CAMERON:—Does the plumber repair the meter or do you repair them, and when it is done do you know whether it is repaired or not?

MR. RICHARDS:—I have a little testing apparatus at the office and if we have any doubt of it we put the test to it. If it comes within a reasonable per centage we let it go. The meters we adopted to save the buying and putting in of larger mains and a new pumping station.

MR. CAMERON:—Is it not your opinion that it is better for the companies to own the meter and have control of them: and, that you could have better control of them if you owned them?

MR. RICHARDS:—I don't see that we could have any better control of them than we have now. We have absolute control of them.

MR. CAMERON:—You don't own them; you could not repair them.

MR. RICHARDS:—We make the consumer repair it which is the same thing.

MR. CAMERON:—Do you put a seal on them?

MR. RICHARDS:—Not in every instance. We have a seal and use it whenever we think it necessary. Our reason for adopting meters in the first instance was this: Our distribution is not general; that is, the water is not distributed throughout the city. When the meter system was adopted there was one whole ward that had no water in it. If the meters had been bought by the city out of the general taxes, those citizens who lived in that ward in which there were no pipes would have derived no benefit, and they would naturally argue that you had no right to tax them for the benefit of another.

MR. CAMERON:—Who pays for the pipe originally laid in the ground?

MR. RICHARDS:—Well, that dont appeal so directly as this, as the main pipes are not strictly for individual uses.

MR. DARLING:—A meter is a part of the plant. It belongs to the pipe or the engines, reservoirs or whatever else. They are a part of the construction of the system. Some put them to the maintenance account; but that in my opinion is wrong. of course, the repairs are charged to maintenance account, but as a general rule the meter should be charged to construction.

MR. CAMERON:—Now, with us, we have nothing beyond the curb stone; beyond the stop cock box we have no responsibility. We run the lead to the stop cock box and that is the end of it.

MR. DARLING:—That is a common occurrence. Some go to the curb stone, others go to the inner fence, while many companies or departments furnish nothing beyond the main pipe. That is just as you make the rule. We go to the fence line, and then we put the service in the cellar if they desire it, but we charge them from the fence line, in.

MR. CAMERON:—I think this argument has drifted a little from the point at issue. As I understand it, Mr. Darling advocates the meter as a preventative of waste. From that standpoint I am with him. From the peculiar location of our plant I am in favor of the companies owning the meters as a part of the plant, but that, I think is a matter controlled entirely by the men who own the water works, but as far as the saving of water, and the paying for the meter in the saving of water, is concerned, my experience has been in the last eighteen years,—during which time we have had, I suppose, 300 meters—that they are very valuable. To cite one instance: We had a livery stable assessed at full value, five dollars per month—sixty dollars a year. We put a metter on them, and they used the first month at the lowest rate we could charge them twenty-eight dollars. I think the meter cost twenty-two dollars. By a compromise, we settled that bill at half price, but the footings for the past ten years show that the livery stable that paid us five dollars a month is now paying us twenty-two and twenty-three dollars a month and not using one twelfth of the water it did formely. And that I suppose is the expertence of any water works man who has tried the meter. It will about cover the case of any large consumer.

MR. GARDNER:—Ownership—that is the question.

MR. CAMERON:—I am not talking of ownership. That is a matter that is governed by the circumstauces of the case.

If you own the plant you want to run it as economically as possible, to make dividends. You want to give the consumer everything on earth he is entitled to, but you want to give the stockholder who has risked his captital in it, what he is entitled to. On the subject of private houses being supplied with meters, my idea is that there should be a minimum rate of say, twenty-five dollars I would say in my country for a residences with all the privileges, thirty dollars a year, and then to charge the consumer afterwards what he uses in excess of that. There is no use of putting a meter in a private residence except in extraordinary cases where you find a leak or a disposition to perpetually waste water; then I would say, attach the meter. Now, as I am on the subject of water, I call the attention of the members to these two samples of water I have brought here. (exhibiting bottles of Wolf River and Artesian water), we have now changed from this water (Wolf River) which the people had to waste a great deal of in order to get any fit to use.

Mr. Gardner:—Is that the water you make your bricks from?

Mr. Cameron:—Yes, while using that water we had to be lenient with the people because unless they allowed the water to run, the pipes would stop up, and we have not had any meter but the Crown or Worthington that would measure it. But now since we have this other sort of water every drop of it is represented by greenbacks, and that is in the coal and plant and wear and tear of machinery. This water we can't afford to let run to waste. Therefore I suggest to our Board of Directors that we have a house to house inspection, shut off every man who is found wasting water, and charge him a dollar, as my friend over the way suggested, or two dollars, and if necessary have a policeman to accompany the inspector to do it, because we have now an article that is worth money, and they ought to pay for it. I am with Mr. Darling entirely in his remarks on the subject of waste of water. If it were practicable, put meters in the houses of all private consumers, and it would be to the intrrest of the water company.

Mr. Gardner:—Mr. President, may I not ask if you will not favor the association with your views on the subject. The question is, "Who should own the meters?" The question of the propriety of the use of meters, I think cannot be in dispute; I think we all agree that meters should be used, but who should own them—the consumer or the company?

THE PRESIDENT: I would say that would depend upon circumstances. In our practice a man comes to me and says "I want a meter" it has got to be very fashionable in our city, but we had a long war over it in the attempt to put meters upon the service. Now, if a gentleman says, "I want a meter" and the water company don't want him to put one on for any reason—for instance his plumbing may be perfect we say, "Well you must buy a meter such as will meet with the approval of the water company, and you must in advance sign this agreement." And that agreement sets forth that the water company shall be permitted to examine the meter at any time, and that they shall be permitted to take it out and test it if they suspect or doubt its accuracy, and that at the expense of the consumer. It also provides that if the meter is injured by over-pressure, sand, grit or anything that comes in constantly and without the fault of the water company, it is to be repaired at the expense of the consumer. But, he says, "you put in a meter for John Jones or Thomas Smith and we want you to furnish it." Well, we say, "If you will enter a contract to pay us the minimum rate of twenty-five dollars a year we will furnish you a meter." He replies, "Suppose I do buy a meter, I am going to move out of that house, I don't know how long I will stay there and I don't want to own it." "Well, a meter is a matter of personal property and when you move you can let us know and we will detach it and if you have not damaged it we will buy it." "Will you agree to buy it back?" "No." "Why wont you?" "Because we do not want that element brought into the contract: we sell the meter to you and it is yours and we don't want to be compelled to buy it when you say we must: we want to have a voice in that." Now, there is this principal of law: there are two sides to this matter: it is a contract between two persons, the water company on one hand agreeing to furnish water and the consumer on the other hand agreeing to pay for it: but it is not an analagous case to the groceryman and his customer, for there the customer has measured before him by the seller what he has to pay for. In the case of the water consumer there is a measure placed there for his benifit and he is allowed to take what he pleases, when he pleases and in your absence; and that is the reason why you have a right to demand that he shall buy and put that meter in its place. Now, as to the policy of the thing. I think there is no unrestricted rule applying in the matter. I don't want to put a meter that costs fifteen dollars by the time it gets into my meter store-room for the sake of reducing a man's rate from what it would be, twenty-five

dollars down to four dollars a year. It is not fair to ask me to do that. So, we say, if you want to save money you can save it but you must save it at your own expense. For the benefit of one the speakers I will read a sentence or two from a case which is backed up by law decisions of a very high character. "Consumers must comply with reasonable requirements."

(See Proceedings 1887, page 83 etc., Secretary)

I would like to ask Mr. Darling if he requires deposits for meters?

MR. DARLING:— No sir; we do not require any deposit because the city owns the meters; it is a part and parcel of the water works. When a man builds a house he applies for the water; we take down what he is going to use it for; he wants one faucet for one purpose, and another for some other purpose; he wants a cock for wetting the yard; he is going to have a bath tub, these are all put down. That requires him to have a meter under any circumstances. It is not for him to elect whether he will have it or not. We simply say to him "you take a meter" and he does. We charge him ten dollars, the minimum price, in advance for his water. Now, if he exceeds ten dollars in use of course he pays for the excess. He may build six houses in a row and call for one meter and that one meter will cover six houses Practically then he pays for what water he uses; his ten dollars is paid in advance on the meter, but his water bill for these six houses may be sixty or seventy-five dollars more. That is paid quarterly.

MR. DENMAN:—You get something in advance?

MR. DARLING:—We get ten dollars in advance. We sell him ten dollars worth in advance; he may get a faucet which will amount to eighteen or twenty dollars but he may not use but ten dollars in the whole year.

MR. CAMERON:—If they are first class tenements you don't get but ten dollars.

MR. DARLING:—We get ten dollars if they don't use but three or five faucets.

MR. DENMAN:—Suppose irresponsible persons demand meters.

MR. DARLING:—They can't get them till they pay ten dollars or proportionately for a part of a year. For instance, a man's bill is ten dollars a year; he wants the water only for

a balance of six months, then we take off five dollars, or for every month we take off eighty-three cents.

MR. DENMAN—Suppose it comes a cold night and freezes.

MR. DARLING:—He pays for the freeze.

MR. DENMAN:—If he is responsible?

MR. DARLING:—We hold the property for the water bills or abuse of the meters.

MR. DENMAN:—If a barber or restaurant man comes into your office and demands a meter—

MR. DARLING:—He don't get it unless he owns the property. We require that owners shall make application for water, and hold the property liable. If a man sells his property and leaves an unpaid water bill we hold the premies for the amount for that bill, the same it is held for taxes, and the property must pay it.

MR. DENMAN:—Then you have an ordinance providing for that?

MR. DARLING:—No sir. I can see very well the difference between a city owning its own water works and a corporation that is subject to the city.

MR. DENMAN:—You have an ordinance permitting you to make that charge on the property?

MR. DARLING:—It is the law of the state.

MR. DENMAN:—Then you have an advantage under the law that no private corporation has.

MR. DARLING:—I understand. I do not put private corporations into that position. I am simply talking from a standpoint of where the city owns its own water works.

A MEMBER:—You don't care whether you make any money or not?

MR. DARLING:—Yes, we do. We take care to see that it will pay us. I simply give you my experience as an illustration of how it can be done by any city or town if properly conducted.

MR. DENMAN:—Have you ever met with any losses from freezing that you cannot collect?

Mr. Darling :—No sir ; I never had a meter to freeze but what I collected for it. They are compelled to pay it or the water is shut off.

Mr. Denman :—I take it you collect the bill without suit ?

Mr. Darling :—Yes sir ; I never sued anybody in the world.

Mr. Denman :—But have you the right to levy against the property without suit ?

Mr. Darling :—No sir ; we should have to commence suit. I should apply to the city solicitor ; I would say, "Here is a bill," and put into his hands for collection. I never had a difficulty or unpleasant time with any one. When he comes to pay his bill, of course, he will fire his mouth off in good shape, but he has to pay before he gets through. I have never had any person say finally he would not pay.

Mr. Darling :—We have a gentleman here from Cambridge, and I say in my paper, "except water works where they have a systematic inspection." Now, I want to say to you that Mr. Nevons, the President of the New England Water Works Association, has a water works in Cambridge where they are using about the same amount of water we do, about 4,000,000 gallons a day, and he has but few meters for he believes in a systematic house to house inspection. The law there is that if a man is caught wasting water they are allowed to fine him. I would like to have the gentleman called upon to give his experience, for I am sure it would prove interesting to all of you.

Mr. Bowen :—To go back a little in this discussion, there is a question I would like to ask, as we seem to have diverted somewhat from the point, and that is, as to the right of a private company to charge the consumer who elects to buy his own meter, a minimum rate to cover the cost of inspection and frequent taking of the meter statements. What is your view of that question ? Has the company a right to say to the consumer that notwithstanding you are willing to buy a meter and have it set at your own cost, nevertheless we insist that we shall derive a certain minimum revenue from that ?

Mr. Denman :—Well, I would think so, unless there was something in your charter to forbid it. In my own case I would refuse to furnish the person with a meter. I would say, "The law gives us the right to make an assessment and you must abide by the assessment." Otherwise

I should not undertake to charge a minimum rate. I would let him have the water and charge him for what he used. I do not know that there is any law on the subject. I was about to say that the moral effect of wasting water is even worse on a community than any loss that occurs to the water company. I know of a neighborhood where a certain man, who has what they call a "pull" on the water company, has three fountains in his yard and keeps them running all the time until the weather gets so severe as to make it inconvenient to get around the yard, and then he shuts them off, and as soon as the spring sun makes it warm enough he starts them again. He was the projector of the company or something of the kind, and when sold out he reserved the right to use as much water as he pleased for his necessities, and under the plea of necessity he wastes an immense quantity of water. I am told that that is an awful wasteful neighborhood, brought about by such an example. It is an illustration of the moral effect—a thing that costs a man nothing he wastes, even though it costs somebody else severely.

My experience accords with Mr. Darling's in another respect. We pump more water in January than we do in July. When the thermometer is 32 or 33 degrees below zero in the city of Des Moines, and it often stands that way, is the heaviest pumping we have, we have to pump nearly four million gallons a day, while the normal use of water is only a million and a half gallons. Of course it is easily to be perceived how and why it is. It is because the people, in order to keep the pipes from freezing and bursting, allow the water to run.

Another thing he spoke of, and with that I am done. In all my experience I have never seen an over-registering meter. I have tested a great many of them. We have, I should say, 1,200 of them in use in Des Moines, and I have never seen a meter that over-registered unless it was imperfect in some way, but not designedly so. So I think any one who has no experience, may safely say to the consumer there is no danger of the getting an over-registering meter. I have a number of times offered a hundred dollars and offered to pay all expenses to any one who would find an over-registering meter in the city.

Mr. Darling :—I want to say one word on that subject. We must educate the parties who own the meters. We must prove conclusively to the customers that a meter will not register against them. It is the general feeling among consumers that the meters are wrong ; they feel as if they were being cheated and we must strive to educate beyond that point. You have to take them personally and explain so that

every man that disputes his bill can see it. That is an important duty we have and we should do it and do it pleasantly and agreeably. But when the final comes tell him what you will do, and do it.

I find another thing : for instance, you take a man who wants two faucets, when he begins he don't take a sill faucet but takes two faucets in the house, he thinks that is all he needs ; but then comes a day in July when it is pretty hot around the house and his garden is drying up, slips the hose on the inside at the sink and runs it out of the back window. That is not the only time he will do it, he has done it once and he will continue to do it until you catch him.

Now, I find this : when a man has a meter and is allowed to use it for all purposes, it makes a man out of him ; he feels a great deal better; he says, "I have a right to use for what I please and I will take a meter and pay for it, then if I need the water I can use it." For this reason, if for no other, I would advocate the use of meters. I think it is the duty of every city or town to do it. I have nothing to say about a private corporation ; I have no advice to give them because they are supposed to know their own business ; I think, though, that if I were to build and maintain a water works, I should introduce the meter system. I feel perfectly sure that in the end, my dividends would come all right.

Mr. President :—Now the Association would be glad to hear from Mr. Nevons on subject of house to house inspection.

Mr. Nevons :—I am sure I feel highly flattered by this invitation, but I had determined when I came to take a back seat and listen. I formerly worked on vessels, and I thought that in Boston we made everything the very best that could be made, so when I heard these stories of the way they built vessels out on the lakes—that they built them, you may say, by the mile—I did not put much faith in such tales. Well, I stopped off at Cleveland, and the next morning I had all the New England conceit knocked out of me at the first blow ; I had to say to myself "Have we been asleep in New England ?" I walked down to the side of a vessel—I had been at work on one of 1,800 tons and fitted it up with modern appliances—and said to a carpenter at work, "will you please tell me how long the keel of this vessel is ? "Yes, it is 206 feet." The one I had worked on was 96 feet. I asked, "what is the breadth of beam ?" "Thirty-six feet." What as the ordinary carrying capacity ?" "45,000 bushels of grain." I said, "when I go back to New England and tell them I have seen a vessel of such dimensions and carrying

capacity here on the lakes, they will tell me I am blowing." So I have learned to be very careful.

Now, I can't begin to back up half the gentleman has said in flattering remarks about the modest little works at Cambridge. I am a strong meter man ; we only differ in the application and expense connected with it. We use meters on all our large supplies and wherever we think it is for our benefit to put them. We have 73,000 inhabitants to whom we supply water, our consumption being about 4,000,000 gallons. Does any man here recommend putting meters on all our supplies ? I do not think one of you would.

When I went on the works the company told me, "The works are built and you can not get much glory out of it." As I was looking around I found that the consumption was a little large, and that perhaps I might get a little glory out of that. I did get plenty of hard work, but there was small satisfaction in it for me individually. I did not know anything about the water works, and in order to find out whether there was any waste I had to familiarize myself with the works. So I went prowling around at night. At the end of six months I could have shut off a section as well as any man, and in that way I discovered a great many leaks. Our works were built in 1855, and you know at that time there was a great deal of worthless cast pipe of all sorts, and there must necessarily have been many leaks. I found a number of leaks in our main pipe, not one of which came to the surface. In fourteen days I reduced the consumption 300,000 gallons a day.

And another thing, we had a territory in our city that had been filled up ; some water pipes and numerous sewers abandoned, so in that way there were drip holes by which the water could be carried off. I adopted the method of shutting down sections, and wherever I found trouble, I sent an inspector around to the houses the next day with wonderful results. As to this matter of house to house inspection, I think it all lies in having gentlemen for inspectors ; by that I mean a man of gentlemanly appearance, his boots blacked, well clothed, and who behaves like a gentleman when he goes into a house. Let him be so much of a gentleman that they want him to come. Then the people will find no fault with his coming ; they have learned to expect the inspector. We tell ours, "We do not want you to have any words with a consumer ; if they refuse to let you see the meter be as courteous as if they had let you see it, come away and report at the office." We had one instance only where we had serious trouble, and in that house we found a leak that had been going on for three years. I was three nights on that section

trying to determine where the leak was and to shut it off. The inspector I had sent could not get in, and he was ashamed to tell me of it. I finally sent the regular inspector on that route and he reported to me that they refused to let him into the house. I went right down after dinner and rapped at the door. A lady responded and asked, "What do you want ?" I replied, "I want to see the fixtures in your house." Her reply was, "There have been two or three others here, and I am not going to let you in." I said, "Madam I must insist on seeing the fixtures in your house, I am superintendent of the works." She hesitated. I finally said "You can take your choice, either let me see the fixtures, or the water will be shut off in twenty minutes." She finally opened the door, and soon as I stepped into the house I found a bad leak. Now we send our canvassers around in October. They are instructed to see every fixture in the house, and if one should find any leak on the premises to notify the parties at the time, leaving a printed notice. At the end of the week he goes back to this place to see if the repairs have been made, and almost invariably we find that they have.

I Believe in meters. I believe in house to house inspection, especially in new works. I believe in educating the people, as has been suggested. You can make good stringent rules and put on a gentlemanly inspector—a man who is not slouchy or offensive to the people, but a man who is courteous and polite in his manner—and I think we can educate the people in that way. Let them understand that they can have all the water they want to use legitimately but under no circumstances will they be allowed to waste it.

In 1875 there were radical changes made in our city in regard to the grades, in many cases cutting them down so that during the winter many pipes were frozen, and the orders came in so thick and fast for thawing out pipes that an order was issued to the people to let the water run. They will never forget that order when it comes cold weather. The issuing of that order had a terrible bad effect. Now our consumption in cold weather just about balances the consumption in extremely hot weather. As regards meters, I will add my testimony, that I never knew of a meter that would record in favor of the city as against the consumer.

Mr. Cameron :—Mr. Hermany, superintendent of the Louisville water works, ought to be able to give us some light on this subject, as I understand his works pump less water per capita than any other in the United States.

Mr. Hermany:—Mr. Chairman, and gentlemen of the Association, I will endeavor to give a brief resume of the Louisville Water Works Company's practice with reference to meter supplies. This company has always reserved the right to apply meters whenever deemed proper in its judgment ; that was among the first rules adopted and published. It is rarely the case, however, that the company determines the application of a meter, on the contrary it is nearly always the request of the consumer. The first meters were introduced because the parties consuming water under the assessed rate were dissatisfied and appealed for a meter. It was in a rolling mill, in operation just twenty-six years ago this very month, that the meter was placed. So from that time to this, in most cases, where meters are introduced it is at the request of the consumer; in some cases, however, the Water Company elects to attach a meter.

The minimum rate at which meters are given at the present time is ten cents a day. The Company will not measure the water for less than that and a great many people who have assessments made for their premises when the amount exceeds thirty-six dollars per annum attach meters. The meters are used generally on the supplies to manufacturing establishments, hotels and the like; there are very few of them in use upon the services of private families. As to the ownership of meters, they have always been owned and repaired at the expense of the Louisville Water Company. It has always been the policy of the company to do so, as it is believed that the meter forms a part of the distribution. The company extends the pipe to the property line except where the side walk is occupied by vaults, where meters cannot safely be placed or where the service pipe cannot always be safely maintained, then the Water Compony stops with the service at the curb stone; in all other cases it goes to the private premises. The water meters are mostly located on the side walk, in small vaults which are encased with four inch brick walls and capped with a metal cover, having a hole on top that comes level with the side walk.

The number of meters is not very great in proportion to the total quantity of water consumed. We have less than a 1000 in use, while the aggregate number of attachments is 11,000 and odd.

The meter system is believed to be the most equitable way of selling water to all people whose assessments or consumption of water amounts to the limit fixed by the company, about thirty-six dollars a year. The people who appeal from the assessment to the meter are very often disappointed. In the majority of cases the consumption by meter

measurements aggregates an annual amount greater than under the assessment plan, and it is frequently the case that where parties have appealed to the meter they desire to discontinue the meter and go back to the assessment rate. In some cases, however, the meter bills are a reduction on the assessment plan, but that is very seldom. As for the rate of consumption, the city of Louisville, perhaps, uses less water per capita than any city in which water works has been in operation for as long a time as here. The Water Company employs two inspectors, whose exclusive business it is to inspect the waste of water from house to house.

When they inspect a house and find water being wasted, written notification of the fact is given, and after the lapse of a reasonable length of time the premises are reinspeted and usually the repairs are found made. In some cases the people disregard the request and second and third notifications have to be sent and occasionally water has to be shut off in order to secure repairs, but the moral effect, as well as a business effect, the actual results from house to house inspection are good, especially when made in a proper and kindly manner by intelligent and diligent inpectors.

The wear and tear on meters in a water supply like this from the Ohio River which has a great deal of sediment and grit, is considerable. The water meters need constant attention and repairs and they are perhaps more costly to maintain than they would be in cities where the water is comparatively clear; but the company keeps them in repair nevertheless, and experience has shown that it is to the interest of the company to sell water by meter measurement, because if not sold in that way to large consumers they would certainly use much larger volume for the same money than we receive now. Water when gathered from gathering grounds, or when elevated from a running stream into reservoirs and brought into a city, large or small and contained in a system of distribution pipes held in readiness twenty-four hours a day and 365 days in a year, becomes a merchantable commodity and should be so handled, and not as a storehouse of public necessity, to be dealt out in a benevolent manner. I am therefore, individually, clear of the opinion that the meter system is the only proper way to distribute and sell water and that it is the most economical way.

If the water supplies to the cities of the United States were measured, or the water was sold by meter measurement, the volume would be reduced 66%, without any detriment whatever to the public convenience.

My observation convinces me that for every gallon of water legitimately used, that is, used for good and servicable purposes, two gallans are wasted. In a business, which is influenced and controlled by so many varying conditions, it is, of course, a matter of impossibility to lay down any fixed rules, and I think the experience that has been stated this evening establishes that fact. Notwithstanding all that the principle of treating water as a merchantable commodity and so selling it in my judgment is the only correct way of distributing and selling it. I am much obliged to you gentlemen, for your attention.

The President:—The Chair recognized Mr. Donahue a while ago.

Mr. Donahue:—I only wanted to make a few remarks of perhaps a little importance. Several gentlemen stated that they never heard of a meter that registered more water than passed through it. I can, however, instance a case of a meter that registered continually although no water passed through it.

A Member:—That was wind.

Mr. Donahue:—No sir; it was water. This was under peculiar circumstances and might not occur once in a hundred times. We had a meter placed in Davenport, a Sister's Academy. As you may know the sisters are very careful and very industrious. Their water bills were very high, running up as high as seventy-five and eighty dollars a month. They tried to economize in water, and they were very careful; still the bills came up the same. They complained of the meter. We took the meter out and tested it, and found it perfectly correct; there was no fault to be found with it. We asked permission to inspect the premises and make a careful examination We went there and sealed all their taps and watched the meter for several days. We found the meter registering right along with the taps sealed. We naturally came to the conclusion there was an underground leak that did not show itself; so we proceeded to make test for that leak. We disconnected the meter, put on a gauge and pumped up to a hundred pounds pressure on the pipes, letting them stand under the pressure all night, went back the next morning and found no leak in the pipes. The long and short of it was this. This academy was situated about gve or six blocks from our reservoir and pumping station, our high service stations as it is called, where we have a crank and fly wheel engine, and where we have very little consumption of water as the

engine made only about six or seven revolutions a minute; it would stop on the center. The action of the engine was very irregular and slow, consequently there was a kind of a hammer on the pipes at this place. The pressure indicated on the gauge would go up according to the stroke of the pump; in fact, we can watch the stroke of the pump from the pressure on the gauge. The academy building I think is three stories in height, and they had a two inch stand pipe for fire protection; we found that air accumulated in this stand pipe, considerable of it. The meter we had in happened to be a Worthington meter, and the registering part of it was worked by a ratchet. Each stroke of the pump would increase the pressure in this pipe. The air formed a cushion which would allow the water to follow up in the pipe and compress the air. That would allow the piston of the meter to go forward, and as the pump would pause on the center the piston would go back and no water pass; it would go far enough to catch the ratchet and thus register. I cite that case in answer to Mr. Diven's offer of $100 to find a meter that registered without water passing.

On motion the meeting thereupon adjourned until Wednesday morning at ten o'clock.

SECOND DAY.

WEDNESDAY, April 17th.

The President called the meeting to order at 10 o'clock.

MR. RUSSELL:—In further discussion of Mr. Darling's paper of last night I have a few scattering ideas I would like to suggest. Mr. Darling has a very convincing style of reading a paper, and I confess when I got through listening to him last night all my preconceived ideas about the subject were pretty well upset. I had to sleep off effects of his arguments before I could come back to my bearings. It is very easy to undestand how Mr. Darling can get consumers to say things to him that they would not say to any other Water Works Company. I imagine, in fact I am pretty sure, the water Mr. Darling has in use is clear water, as translucent as the Kentucky atmosphere; but we have a different state of things in the west. There the

muddy water that has to be used makes the item of maintenance of meters quite a large one. You will find that the repairs of meters are very frequently of more importance than the original cost. The system we have in St. Louis is very much the same as our President has named: that is, we have a license and the consumer has privilege of using a meter. At the same time, if we think the consumer is using more water than he is paying for we have the privilege of putting in a meter. Now, it has been found that the average consumer, the average householder, cannot afford to buy a meter and pay for the repairs. The repairs amount to more than he can save by taking care of the water. It seems to me that is an argument in the direction of not putting them in, if the consumers cannot save enough in the consumption of water to pay for the cost of putting in and keeping the meter in repair. We get coal for about $1.50 a ton; we have an unlimited supply, so that does not bother us any. As to the size of the pipes, it is true the pipes would not be affected by the use of meters because that is determined by the fire protection. When the pipes are large enough for the fire use they are large enough to supply the domestic requirements, except perhaps the force mains would be required to be larger for domestic consumption. I perfectly agree with Mr. Hermany that the measurement of water and the sale of it as a merchantable commodity is the thing to be aimed at, but I do not think it is in all cases advisable to use them entirely as Mr. Darling does. Of course, if the consumer would not take any more water than he uses, meters would be a pure waste of money; I am a householder myself and I look at the other side of this question, I do not think that consumers as a rule will waste water unless they have some good reason for it. There is one point in Mr. Darling's remarks that I did not clearly understand, and that is in regard to his hold on the property for his water bill; he spoke as if he held a claim on the property that enables him to always get paid for the water.

Mr. Darling:—If the gentlemen will permit me I will make a little explanation on that point. The law of the state provides that the property shall be liable for the water rents. Therefore, we hold them in the same way they are held for ordinary taxes. Every town assesses taxes and the law provides for their collection. In the case of water works we had to have the same principle applied. So, the gentleman will understand that it is a law that produces that result.

MR. RUSSELL:—Does the money come from the landlord or the tenant?

MR. DARLING:—All services are rendered in the landlord's name. The bill is made to him direct and if the tenant sees fit to pay it we don't object; we care not who pays the bill so it is paid.

MR. DECKER:—In my annual report yssterday, I made reference to the death of Mr. Harvey Gaskell, one of our most eminent members, a leader in all matters pertaining to water works and their machinery; and I would move that a committee be appointed to report such suitable action to be taken by this association on the death af Mr. Gaskell as is appropriate to express our sense of the great loss that the country, and this association in particular, has thereby suffered.

THE PRESIDENT:—Gentleman, it is eminently proper that in the midst of the activities of our lives we should pause to drop a tear over the freshly made grave of a departed brother. He has simply preceded us; he has gone the way we must all go, and the days are but short before it will be said of each of us, he has gone. I knew Mr. Gaskell quite well. I knew him to admire him as a gentleman in all that the term implies. Modest in his demeanor, a man who neglected no duty of his life, a man who only forty-four years of age had already filled out a well rounded career. The Chair will appoint Mr. Charles Hermany of Louisville to act as chairman of a committee with the request to him to select his associates for the purpose named in the motion.

THE PRESIDENT:—The meeting will now proceed with the regular order. We have a paper by Mr. Emil Geyelin, entitled "Analysis of Mechanical Filter Actions."

Mr. Geyelin read as follows.

ANALYSIS OF MECHANICAL FILTER ACTIONS

THE PRESIDENT AND MEMBERS OF THE WATER WORKS ASSOCIATION.

GENTLEMAN:—Listening at one of the sessions of last year's meeting in Cleveland, to the report of Captain Richards on the filter plant of Atlanta, then recently put into operation, I felt that a report on filters in general could hardly fail to be of interest to the Association.

I therefore resolved that, if agreeable to you, I would, after continuing my studies, then begun, on various filters, present an analysis of their mechanical action. Though far from complete, I trust they may serve some member in his investigation as to their comparative merits.

As the population around existing centers increases and the streams in their vicinity become more and more polluted, an intelligent community demands of its Hydraulic Engineer to stay the deleterious effect this impure water has when used for drinking purposes, by his removing from the water whatever is poisonous. Three modes of attack are open to him, neither of which when used alone produce perfect results: these are, first, the providing and maintaining an intercepting system for the control of the greater part of the insoluble organic matter, thereby preventing it from entering the river, or, if not practical, the exposure of thus charged water to the oxidizing effect of the air as much as it is feasible. Second, in the storing of the more or less impure water in reservoirs, allowing any foreign matter in suspension to subside and settle to the bottom. Third, which is the mode alone before us, namely, the mechanical, (sometimes aided by chemicals) removal of suspended foreign matter by filtering. Filtration is to-day, alone resorted to where the storing of larger bodies of water is impracticable, yet it could easily be demonstrated that as we advance in the knowledge the application of hygienic laws have on the health of the people, we will cease to fill the bottoms of our reservoirs with putrefying matter, and per contr, filter all water that enters our pumping machinery.

Nature, in proximity to centres of population, in rare instances offers natural filter-beds: these are beds of gravel through which water percolates on its passage to a lower level. The inventors of the various filter systems, adapted to city use, have to a great extent, followed the example nature set before them In all cases either more or less coarse sand or porous or broken material is made to serve as intercepting material. Yet they could not wholly do so, as contraction of space and the demand for comparatively large bodies of water forced them to call in, in some instances, the aid of an accelerator in the form of chemicals, so as to create a coagulant. This accelerator, varying but slightly in quantity in the different systems, depends on the greater or lesser depth or length or coarseness of the filtering material through which the impure water is made to pass.

The object of this paper is to present in a condensed form the mechanical operations of the different filter systems before the public, as well as to point out the different modes adopted for the restoration of intercepting material to comparative purity after it has become charged with foreign matter.

By looking over the list of names and titles of filters to whom we are indebted for the boon of removing deleterious matter in suspense, we notice nine names more prominent: these are the Hyatt, the National, the Oliphant, the Roeske, the Warren, the American, the Crocker, the Jewell and the West.

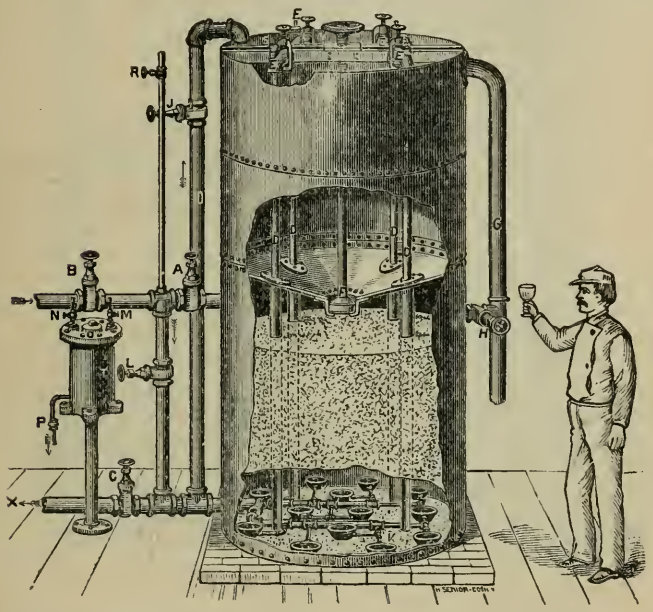
With the view of assisting the members to follow me, I have prepared a chart of each of these several filters, illustrating them as far as I understand their pamphlets.

THE HYATT FILTER.

The Hyatt Filter is a round closed chamber placed in a vertical position made strong enough either in iron or steel, to resist a great pressure. The feature of being closed and made to resist great pressure, (often reaching 120 pounds or more to the square inch) is common to all other filters. I can find but two which filter in the open air, namely,

the Warren and the West. This strong chamber of the Hyatt filter, is divided horizontally into two sections, a lower and an upper one. The filtering material, composed of coarse sand and intermixed with coke, is when in action of filtering, placed in the lower section to the depth of several feet. The water to be filtered is introduced on the top of this filtering material, passes downward and out as filtered water.

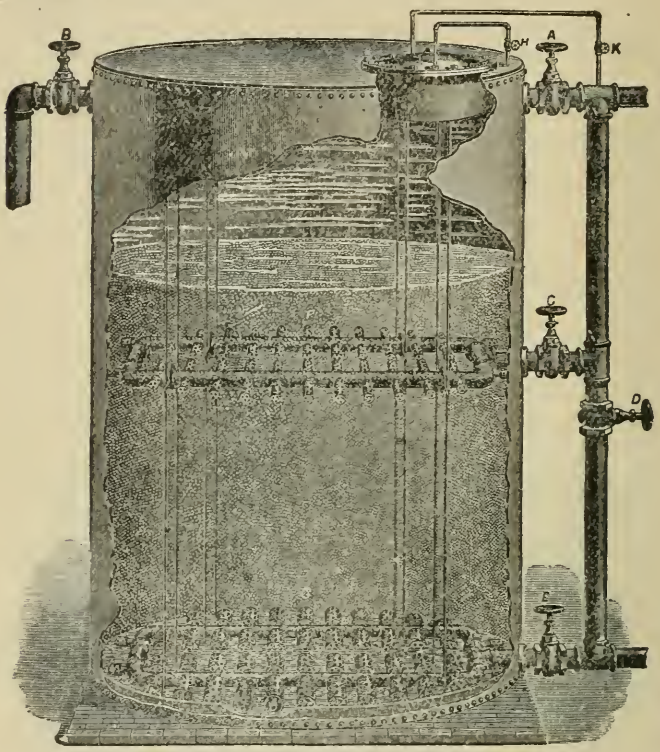
When the filtering mass becomes so clogged with intercepted matter as to materially check flow of the filtered water, the filter is made to undergo a process of cleaning; this is done by admitting water under pressure underneath the filter bed which forces both filtering material and intercepted matter through seven pipes into the upper section of the filter, where the process of cleaning is continued until the water runs perfectly clear. When freed of impurities the filtering material



is made to pass again into the lower section. The interuption of the process of filtering, while the washing is going on, is met in this case, as in all others, by having a series of filter chambers so as to be able to dispense with any special one for sometime. In many instances when the water to be filtered is tolerable free from foreign matter, very little if any coagulant is used, but when used, it is mainly in the shape of dissolved alum in such small quantities as to be in no way injurious to the health of those who drink it.

By following the action of the water and filtering material while undergoing the process of cleaning, namely, by being displaced from the lower to the uppe section, one can hardly fail to note the efficient mode of detaching any film that may have attached itself to the particles of filtering material. It is asserted that this process of transferring is at a cost of a comparatively large body of filtered water

with which it is claimed, per contra, corresponding results are produced. Every gallon of water so used acquired double value, first from the fact of having been acted upon by the pumps, then again by having passed through the filters.*



THE NATIONAL.

The National Filter is very simple in its construction: it is a vertical cylinder filled with filtering material, the water to be filtered passes from the upper part downward and out. For the purpose of cleaning,

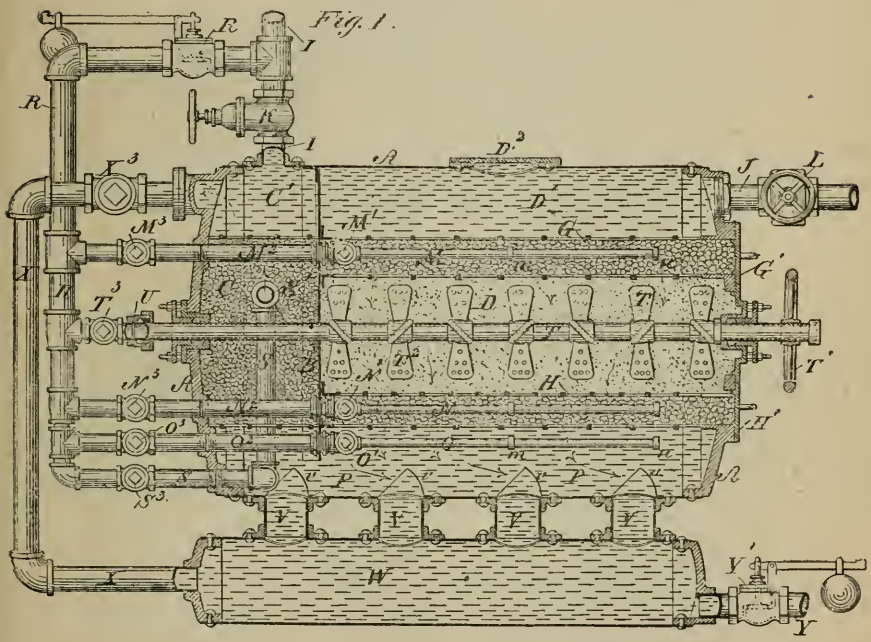
*The Hyatt Company has, since the last meeting of this society, made two other styles of filters. In each case the middle division placed horizontally is dispensed with, it being claimed that this violent action of displacement is not necessary in instances where the water to be filtered does not have a sticky sediment. In the first of these new styles, the filter bed is divided into three compartments, into either of which the full pressure of the pumps can be concentrated for the purpose of washing.

In the second style the filter consists of an undivided chamber, in the center of which a vertical hollow stem extends from the bottom to the top of the chamber. At right angles with this stem extends a perforated arm. This stem and arm can be placed in any position around the center of the stem used, and by means of a ratchet wheel can be held thus, admitting the water for the purpose of cleaning, alternately at all points.

two admissions of filtered water under pressure are made. in each case into perforated arms spread in a horizontal plane. The first is at the bottom of the filtering material, and the second is within five or six inches of the top of the filtering material. This arrangement permits independent cleaning either top and bottom. The top, on account of receiving much the greatest amount of the intercepted matter requiring cleaning the most. a decided advantage is claimed by the owners of this system.

I would however, call special attention to the fact that if the Engineer in making his selection of any filter. has in view the removal of any slimy or sticky matter. with such means as the mere injecting of water into a large body of material, he may not find the desired results to be complete. This remark would seem to apply more or less to most of the filters. Incomplete washing. it is well known. especially where porous substances are used, becomes a source of danger. This is so much the case. that any porous material once saturated with foreign matter. is hardly ever used again for filtering.

Fig. 1.



THE OLIPHANT.

The Oliphant Filter, like its above described predecessors, is encased in a round iron or steel chamber but it is placed in a horizontal position. The impure water is admitted on top of a section filled with broken coke. through which it partly divests itself of foreign matter. At the bottom an inclined plate obliges the water to take a more or less

horizontal direction, when it comes in contact with a body of sand on its way upward. It, like its predecessor, the National, is provided with seperate jets, so as to reach either section of filtering material; having the feature of ending the filtering by making the water take an upward course, it would seem to be the result of mature thought, the result being a filtered water free from any particle of sand*

THE ROESKE.

The recently constructed Roeske Filters are composed of six sections of an annular chamber, filled with coarse sand, and a central chamber filled with broken coke; connection between the outer sections and inner part is made at the bottom. The impure water is admitted at the top, flows downward, enters the connecting pipes and rises to the top of the coke. It is claimed for the Roeske as well as for the Oliphant, that the fact of discharging upwards, prevents any fine sand from following the filtered water and lodging with the valves or stops.

The Roeske like the Oliphant, provides separate jets of filtered water, so as to clean independently, the upper stratum of either coke or sand. The distinguished feature, however of the Roeske is, that it is provided with steam connection, wherewith the filtering material, is made to undergo an occasional boiling bath, thereby dissolving more effectually intercepted matter, and destroying any animalculae that may be in the filter. Since writing this review on filters, I have seen plans of a Roeske Filter intended to filter in the open air, the action of cleaning is identical with that of the closed filter.

THE WARREN.

All the filters heretofore named, as well as those which are to follow, with the exception of the West Filter, are closed iron or steel chambers, the impure water on its passage through the filter being under considerable pressure. The Warren Filter per contra, is an open air filter, that is, the impure water enters an open tank mainly made of brick or wood. The water is made to descend and flows into a side channel under a difference of level of the one at which the water enters the filter of about eighteen to twenty inches. This feature of the Warren Filter especially adapts it in cases where it is desired to filter the water before it enters the pumps. A decided saving is claimed for this feature, as no silicious matter can enter the pumping machinery and cut out the valve seats, piston rods, cylinders or rings. Another distinguishing feature of the Warren Filter is, that during the process of filtering as well as cleaning, a slow, circular rake motion is brought into use, which is operated a few inches below the upper surface of the filtering material while filtering, thus disturbing any intercepted mat-

*Since writing the paper Mr. Oliphant presented to me plans of the construction of a filter, in which the water enters the top, at the small end of a divided cylinder, where it meets coarse gravel, through which the water partly divests itself of foreign matter and percolates downward to the bottom. The lower part of the divided plate being removed, the water passes along the bottom of the long part of the cylinder, from there it passes upward through a series of horizontal screens holding coarse and fine sand alternately, to an upper space as filtered water. The screens are so arranged that they can be drawn independently by opening plates secured to one end of the filter cylinder.

ter from forming a crust. This same rake motion is made use of, when cleaning is going on, by being made to penetrate the whole depth of the filtering material, thereby rubbing against every particle and hastening the time of cleaning which is begun by using first, the impure water and finishing by using filtered water under pressure. We have noted, that in the Roeske Filter, steam is brought into use as an assistant in cleaning. In the Warren Filter we note the necessity of a continuous power to give motion to the circular rake. Where steam is

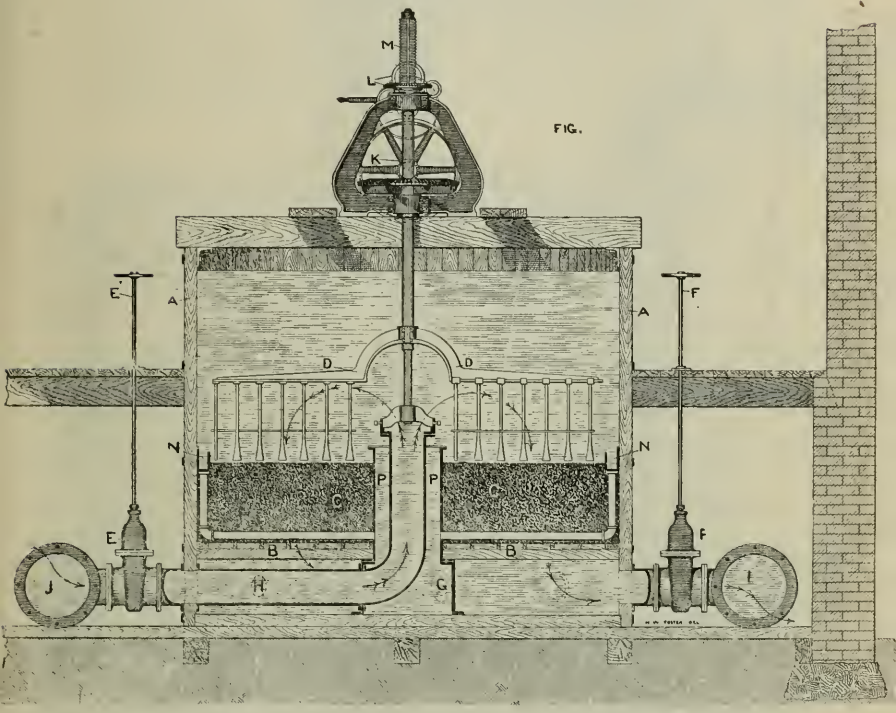


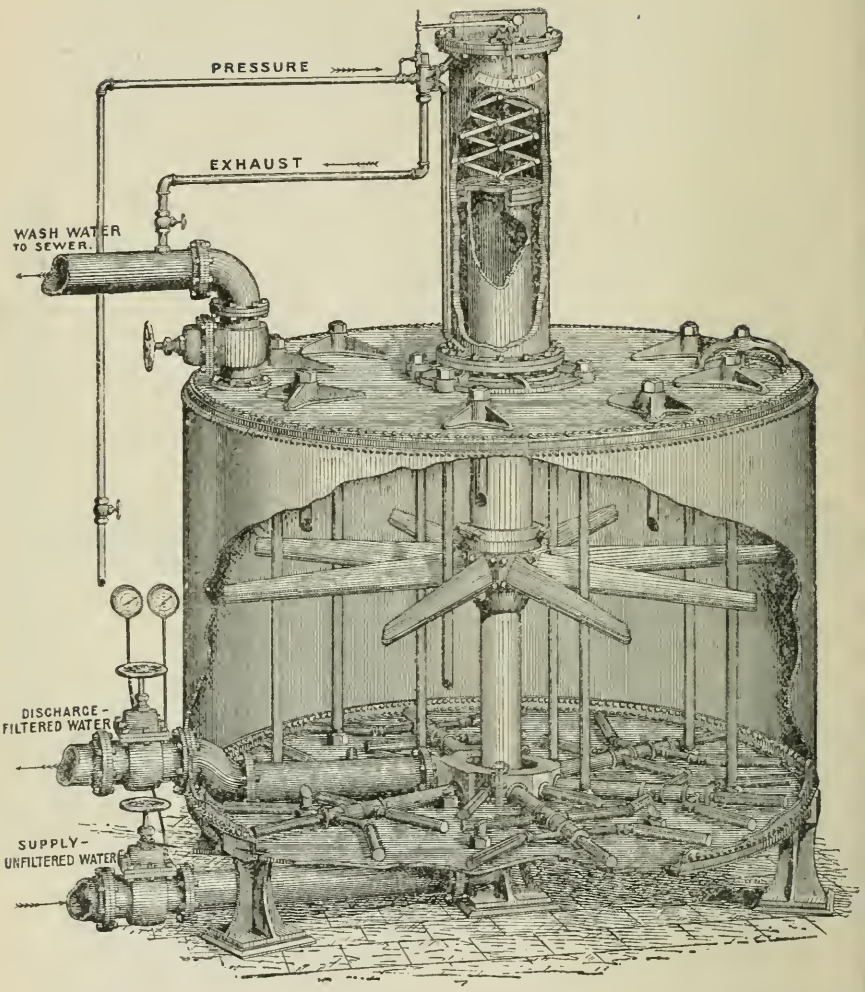
FIG.

at hand for pumping or heating purposes, the cost of the former is hardly to be considered as it is seldom used. In the Warren, it is of some consequence, but not much, as the power needed is slight.

The Warren Filter is also being constructed so as to filter under high pressure; in this case the brick or wood chamber is replaced by one in cast iron. The mechanical action of the circular rake for the purpose of hastening the cleaning process, remains the same.

THE AMERICAN.

The Filter known as the American, is, like all high pressure filters, made to resist great pressure. The impure water is introduced into the



top, the filtering going on by the water flowing downward. The upper strata of the filtering material while the filtering is going on, is penetrated by radiating arms, provided with many orifices, through which an occasional jet can be made to act on the sand. These radiating arms, by means of a plunger, acted upon by Hydraulic pressure, are made to descend to any depth of the filtering material and at the same time eject clear water under pressure.

Looking at the large body of sand and the numerous arms, it would seem that with a very great pressure of water alone, the particles of

sand could be sufficently acted upon, to thoroughly clean them. This filter presents a valuable feature, namely, by means of pressure guages put on both the receiving and the discharge pipes, the operator can ascertain to what extent the filter is clogged.

THE CROCKER.

The Crocker Filter is a closed oblong cylinder, holding the usual filtering material. The process of filtering is upward and at the same time a more or less horizontal direction. The distinguishing feature of the the Crocker Filter is, that for the purpose of cleaning, the cylinder with all its contents, is made to revolve horizontally on trunnions secured to the ends of the elongated cylinders. The effect is the tumbling about of the filtering material, which necessarily shortens the time of cleaning. This is as stated before, a factor in estimating the merits of filters.

THE WEST SYSTEM

The West System, like the Warren, is an open air filter, the water is received in its impure state into a series of reservoirs placed immediately over corresponding series of filtering beds, the bottoms of these upper reservoirs are perforated in so minute a manner as to allow the water to pass only in a restricted and divided manner into the filter bed underneath. The advantage claimed for this arrangement is, that it relieves the filtering material of any excessive pressure, which a large body over it would cause, but as the capacity of filtering of a given bed must necessarily vary as the bed becomes clogged, the surplus water must accumlate on top of the filtering material. The water from the upper reservoirs passes downward through the filter bed and enters still lower down and separated from the latter, into the channel into the large reservoir immediately underneath. The water, percolating into space, is thus exposed to the oxidizing effect of the atmosphere, which is certainly a valuable feature of the West Filter. There remains yet another distinguishing feature in the West Filter, namely, that it is placed under a roof, thus preventing the action of the rays of the sun having an injurious effect on the water. This idea is, however, only applicable in the case of small filters.

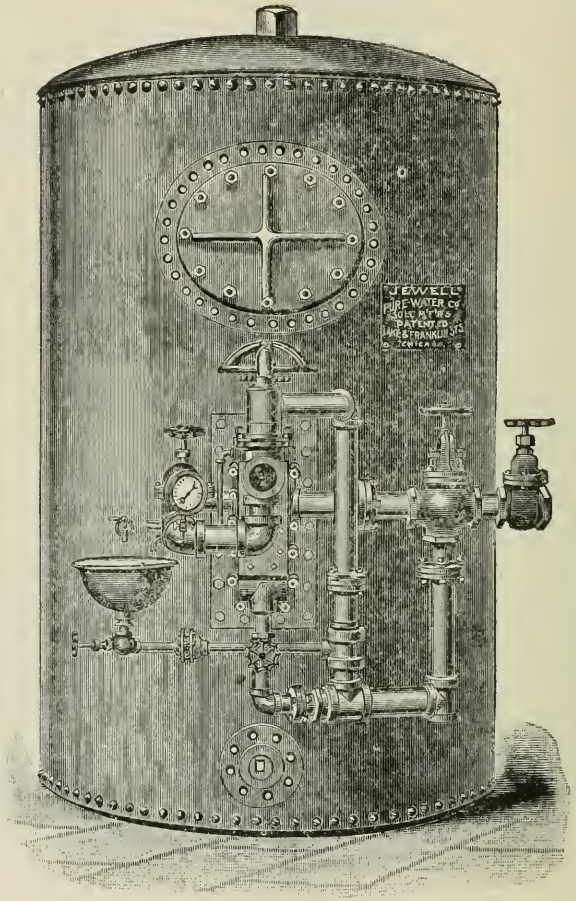
Coming now to the manner of cleaning the filtering material in the West System, the most important feature in any filter, there seems no further provision made than for the actual bodily removal of the filtering material, charged with intercepted matter, each time the filter bed needs cleaning. For this removal however, every facility is made by way of hoists and tramways. In this system, it will be noted also, that there is no provision made for injecting clear water under pressure to dislodge and dissolve intercepted matter, nor are there any means to collect the filth charged water, neither is there any local mechanical appliance to hasten this cleaning process as is the case in others we have passed in review.

THE WARREN HIGH PRESSURE.

Acts like the open air filter, but is enclosed in an iron chamber so as to withstand any pressure of the water.

THE JEWELL.

The Jewell System consists of an upright steel cylinder, strongly made, and water tight, filled with ordinary filtering material. The water to be filtered is admitted to the top and pours downward and out through a half dozen collecting screens, merged into one. For the



purpose of washing the filtering material, when charged with foreign matter, clear water is admitted under pressure, at the very bottom of the filter through hundreds of small valves ingeniously constructed. The current is upward and will free the filtering material of any impurities. It will be noted that the Jewell provides no means of injecting

clear water immediately below the upper section of the filtering material, thus no partial washing can be done, the owners of the system claiming it is not desirable or advantageous. Looking now at the whole filtering family, one notices but slight difference either in filtering material used, or the likely results obtained under similar circumstances. The water is made to pass for a longer or shorter distance through more or less sand or broken coke. The flowage being retarded correspondingly much or little, as the distance is shortened or lengthened on the one side, or the material is coarse or fine on the other. The main difference seems to be in the modes of cleaning the filtering material. In some cases, we have the action of the water pressure alone, as is the case in National and the American. In others we note the injection of water, joined by the injection of an occasional steam jet, as is the case in the Roeske; again we note the mechanical action of displacement, as is the case of the Hyatt and Crocker; finally the kneading process by circular rake in the Warren.

Wishing to confine myself to explanations of the mechanical action and the different modes of cleaning, I refer those interested in other details to the agents representing each company. They are as follows:

The Hyatt Filter, by the Newark Filtering Company; Tribune Building, New York.

The National Filter, by the National Water Purifying Company, 145 Broadway, New York.

The Oliphant Filter, by the Oliphant Manufacturing Company, 98 Liberty Street, New York.

The Roeske Filter, by John Baizley, 520 South Delaware Avenue, Philadelphia.

The Warren Filter, by the Cumberland Manufacturing Company, 220 Devonshire Street, Boston, Mass.

The American, by the American Filter Company, Chicago, Illinois.

The Crocker, by the Crocker Filtering Company, 114 Cherry Street Philadelphia.

The West System, 115 Broadway, New York City.

The Jewell, Pure Water Company, Lake and Franklin Streets, Chicago.

MR. OLIPHANT:—I want to say that the filter mentioned in that paper as mine does not describe my filter at all. I have the blue prints down stairs that I should like the gentlemen to inspect for themselves. If Mr. Geyelin had got the same information from me as he seems to have gotten from the others he could have avoided the wrong statements he has made.

MR. GEYELIN:—I had these descriptions and representations of the different filters from all the filter companies, and this one represented as the Oliphant from some representative of that company. Anything omitted in the description as given can be of little or no importance; the principle is just

the same. I am aware of nothing unfavorable that I have said of the filter.

Mr. Oliphant:—If agreeable, I can bring up my blue prints and will satisfy this meeting of what I say, but this is no place to discuss filters, but to remove any doubt here I say my filter has not been described at all.

The President:—The character of this paper is intended to be general and a discussion of filter plans in general is perfectly allowable. I think, however, the rules of the association will not permit a discussion of specific filter plans. Certainly we have no time in the two days remaining to us to enter into such wide range of discussion even if it were legitimate. I think I can say with perfect safety that if there has been any misrepresentation of the Oliphant filter made, Mr. Geyelin will cheerfully correct it. He is not here in the interest of any filter, but has simply discussed generally the characteristics of filter plans. And I repeat that if there are any mistakes in the paper that has been read I will vouch for it that the author will correct them with pleasure. (Applause). Now, the general subject of mechanical filters is before the meeting for discussion.

Mr. Caldwell:—In behalf of the Hyatt company I wish to express our appreciation of Mr. Geyelin's very able paper. I think it shows that he has been at great pains in collecting his material, and that he has exhibited wonderful accuracy in his treatment of the subject for one not actually engaged in the business. I appreciate the fact that it is a difficult matter to prepare an intelligent paper that involves the discription of nine different filters, even for a man who has direct connection with the manufacture of them; it is an extremely hard task to collect all the details necessary for as comprehensive a discussion of the subject as Mr. Geyelin has presentd in his paper, and I think it has been done with great clearness, fullness and above all with perfect fairness. Indeed I do not think Mr. Geyelin could be unfair if he were to try to. (applause).

The President:—We will take up the next paper on the programme which is "Water Works Construction from an Engineering, Financial and Municipal Point of View."

The Secretary:—I owe to the association, and to Mr. Pond also, an apology for inserting that paper in the program. When I requested Mr. Pond to furnish a paper for this meeting of the association, he agreed to do it, conditionally, and

one of the conditions he imposed, was that I should not enter it on the program without his informing me that he could come. In the hurry of making up the program I forgot and overlooked his request and my acquiesence. He has not been able to complete his paper because as he writes me he has been quite sick, and he had discovered it was a subject that would require a good deal more time to properly handle than he had anticipated. I make this explanation in justice to Mr. Pond. A query has been handed me to be put to this meeting. It is, "If an order be sent to a valve manufactory for a thirty inch high pressure valve, and one is received which breaks under high pressure, but which would have withstood fair pressure or steady pressure, would it be considered it was properly constructed, and if not, at whose expense should the damage be repaired, not only in the matter of replacing the valve, but also for the loss of water, the damage to streets and pavements, to say nothing of damage to the fire department in time of fire, etc."

The President:—The question divested of some of its verbiage, as I understand it, is simply this: If I buy a thirty inch valve and put it in on my water system and under a pressure of less, we will say, than 300 pounds, or less than 200 pounds, and that valve breaks and thereby causes damage in the neighborhood, should the valve manufacturer in honor, we will say, be held liable, not only for the cost of the valve but the cost of the repairs also? That is the first proposition.

Mr. Gardner:—I should like to ask for my own information whether a valve of any size is not supposed to be capable of the same amount of resistance as the pipe on which it is placed. Let us put it in that shape—whether it be a thirty or a three inch valve, ought not the valve to have the same power of resistance as the pipe to which it is attached.

Mr. Linnèen:—I think that is a very proper question for this association to discuss. I do not think by the discussion of it we necessarily resolve ourselves into a court of law or sit as a jury. These are pertinent questions and questions which can be discussed intelligently by this association. Now, it seems to me there are some questions that enter into the consideration of this one that we have lost sight of. If a thirty inch valve is ordered by myself, or by any gentleman present, it is to be presumed that he will state to the manufacturer the pressure under which we want that valve to

operate, whether three or four or five hundred pounds. If an order is given for a valve for a pressure of 300 pounds and the valve is tested at the works to stand that pressure—mechanically and well tested, and it is taken out of the shops and put in practical use on the line of pipe, it is possible there may be mechanical defects in that valve that could not have been determined at the shops when it was tested; that is to say, if the manufacturer uses all possible and proper means to test that valve before shipping it, I do not think any damage resulting from an inherent defect, which could not be discovered, should be charged to the manufacturer. But on general principles when valves or pipe are ordered it seems to me the conditions under which they are to be used should be stated in the order. That would give the manufacturer an opportunity to meet the requirements of the order. Now, in sending orders for valves to the manufacturer in my experience it is very rarely that the pressure under which the valves are to operate is stated: the manufacturer has to draw largely his own conclusions. He may presume that the highest test necessary would be 150 pounds, and unless valves are constructed specially and under a special order, there are very few that are made for over 150 or 200 pounds pressure. As I have said, in my opinion these questions come properly before this association for the instruction and information of its members.

Mr. Cairns:—This is a question which of course has come up for discussion time and again in the office of every valve manufacturing concern in the United States. Of course, its ethical side is one which concerns all honorable men—and we are all honorable men in that business. As has been well said, a good deal of our trouble arises from indistinctness in the order. For instance, a man will tell us he wants a valve to be used under such a head or pressure. Now, it is highly probable—I think it is very common from my conversation with water works men, that this matter of water rams is not entirely reduced to anything like knowledge yet: I do not think water works men perhaps altogether understand it themselves: I know we do not; and moreover I think under certain heads and certain pressures the conditions of service may cause a difference in water rams. Now, if an order is sent in requiring us to furnish a valve for certain pressure we, of ourselves, must determine what test is to be put on it. If it is to be used under ninety pounds pressure it is usual to test it up to ninety pounds because we know there is a water ram, but we do not know

what the water ram will be. So there is a trouble. If that valve fails some day I do not know that it can be followed back to the manufacturer, because there may be a ram there that under certain circumstances would amount to 500 pounds, you cannot tell, it is impossible to tell afterwards, there is no record by which to tell under what pressure the valve broke. If the man tells us to test the valve to a certain pressure and we test it then we are relieved from responsibility. In regard to the other question, as to what a high pressure valve is I think it is commonly understood to be 300 pounds, but as has been said it is an unusual test.

Mr. Potts:—In answer to the question suggested I have an instance in my mind—I believe it was Mr. Beecher who said there was no part of a chain that was stronger than its weakest link, so there is no part of a water works that is stronger than its weakest part—I have an instance in my mind at this time of a valve—I think it was a twenty inch flange valve, or twenty-four; I know that valve was tested in the shop at 200 pounds pressure; I know that it was examined by mechanics after it left the shop and while it was on the ground and it was considered a perfect valve. It was put in position and served its purpose for quite a number of weeks or months; but in the laying of the pipe there was a little negligence on the part of the engineer perhaps is not providing proper foundation for the pipe to lay on, but the pipes were made excessively strong, and they settled a little bit—I think only about half an inch, and that broke the valve in two. Now, that valve unquestionably was made honestly and squarely by the manufacturer, but when the question of damages came up they fell back on the valve itself, when the valve was in no way responsible for the accident.

Mr. Cameron:—We had an experience with a 26-inch valve where under a pressure of sixty pounds to the square inch the flange of the valve broke loose; the bolts gave way and caused us considerable trouble and expense. We notified the valve manufacturing company which happened to be the Ludlow, and by the next express came the necessary materials to repair it with a request to us to name the amount of damage that had been incurred. That is all the experience I have had.

Mr. Jones:—This information is wanted by a friend of mine, and I think for the most part the information wanted was, what would be considered or understood by the term

high pressure? and whether a valve which is intended to resist high pressure should break under a pressure of less than 200 pounds. It would not be so surprising to have one valve break, but here is a case where two broke on the same night, and it leaves the impression that it is due to faulty construction, or else that the builder did not take sufficient pains to find out how much pressure the valve was expected to stand, and the only question is whether the fault lay, as has been suggested, in giving the order imperfectly, which simply called for a high pressure valve. A great many people not engineers take it for granted that a high pressure valve stands any pressure. My impression has always been that they were tested to 300 pounds, and if so, it ought not to break at less than 200 pounds.

MR. CAMERON:—I would like to ask if the two broke on the same occasion?

MR. JONES:—It was not the same occasion.

MR. CAMERON:—My conclusion from listening to the testimony would be that the valves were back numbers and faulty.

MR. DIVEN:—I don't see why a 30-inch valve would be more liable to give out than a 6-inch; I suppose they are all made in proportion. The 30-inch should be as strong in proportion as the 6-inch.

MR. CAIRNS:—The position taken by Mr. Lineen is correct. One of the greatest troubles we find with such orders is that the person does not state under what presure the valve is to be used. One of the first questions we are obliged to ask on receiving such orders is, "What pressure do you propose to have on this valve?" The smaller valves up to twelve inches are usually tested up to 300 pounds. I have a case in mind where we have a steam valve in use that we guarnteed to stand 125 pounds steam; that is now under pressure of 140 pounds steam and resisting it successfully. The great trouble with larger valves is when they come to test them it requires an unusually heavy pressure.

A MEMBER:—It occurs to me that to describe a valve to resist 300 pounds pressure and not take into account any possible water ram would be very little information to the valve builder. We know the shape of the valve as compared with that of the pipe is such that it is a difficult matter to get a valve as strong as the pipe unless we load it exceedingly. Now, in one case we may have a pressure of 300 pounds and

so state to the valve builder. At the same time we may have a water ram of twice that amount, and under such circumstances the builder not knowing what the possible water ram may be, his valve may prove deficient and burst. Now, it does seem to me if the builder had some inkling as to the amount of water ram he would have to contend with, it would give him a better idea as to how to construct his valve and avoid defects that would otherwise occur.

MR. KEELER:—I would like to ask whether both valves broke under the same pressure. That might determine whether the valves were built in proportion to the work.

MR. JONES:—One of the valves was broken under a fire pressure of about 160 pounds. The dome was split and was subsequently capped with flange casting and the line again put in use. In order to test the other valve, without encountering the mysterious water ram, a three-inch connection was made with the 30-inch main and one of our pumps,—the whole line being valved off from the balance of our pipe system—the main was filled slowly, the pressure was necessarily very gradual, and at 185 pounds the valve went to pieces. It has been suggested that the explosion was the result of the accumulation of air in the main, which might have been the case, but we notice it had no effect upon the mains, nor upon the Ludlow valve of the same size on the same line. The cast iron pipes are warranted and are tested to stand 300 pounds pressure, and I believe all valve manufacturers pretend to guarantee the same thing. A good deal has been said about the water ram; no one yet has been able to describe to my satisfaction its extent or variation. I am not competent myself to tell, but we cannot afford to have valves broken, bursted or exploded either by water pressure, water ram or compressed air.

MR. BUSS:—The fire pressure you say was 160 pounds; what was the ordinary pressure?

MR. JONES:—One hundred and thirty pounds.

MR. BUSS:—What pressure valve was ordered?

MR. JONES:—There was no mention made at all of the pressure; it was ordered by telegraph simply as high pressure. That is the reason the term is used here, to find out what the term "high pressure" conveys. My impression has always been that high pressure meant any pressure above 200 pounds.

MR. BUSS:—The reason I ask is, I know a case in Massachusetts where the ordinary pressure is ninety pounds, the fire pressure 150 pounds. Now suppose we ask a superintendent what is the pressure? The natural thing for him would be to say ninety pounds, while under some conditions the pressure would be 150 pounds.

A MEMBER:—I should think in ordering a valve the person ordering ought to give the minimum and maximum both.

MR. ROSS:—I would state that if we had an order for a heavy pressure valve, we would understand 175 pounds pressure, which we think is above the usual working pressure of valves, but that valve would be tested to 300 pounds pressure.

A MEMBER:—I would like to ask the gentleman, if he received an order for a 30-inch valve if he would test it to 300 pounds?

MR. ROSS:—Yes, without any other information.

A MEMBER:—What thickness of iron does the gentleman use to test at 300 pounds with a 30-inch valve?

MR. ROSS:—That is a leading question.

A MEMBER:—I ask the question. If I got up and made an assertion of that kind I would feel at perfect liberty to back it up when called on. It is any easy matter for me to get up here and say I would test a thing at a certain pressure but it might be another thing for me to explain how I would do it. I think it is a fair question.

MR. ROSS:—I would answer the gentleman that we construct valves and vary the thickness according to the different areas of the valves and the pressure they have to stand. It is not of the same thickness throughout. I could not inform him as to the exact thickness.

MR. DARLING:—I would say that of course every superintendent understands that the main pipes are tested, whether his pressure is sixty or eighty or one hundred pounds, to a certain pressure. Some superintendents call for a thirty pound pipe—take a six inch pipe to illustrate; some say, I can get along with a twenty-four; another wants twenty-six, another twenty-eight, and up to perhaps thirty-two, which is called a very heavy six inch pipe, and you will find whatever the thickness or the weight of that pipe is it is tested to 300 pounds to the square inch—every pipe. I think I can state

that here openly, and that if Mr. Long were here he would endorse it. In fact I have seen in Mr. Long's works pipe tested, and I understand they put out none for water works purposes at less than 300 pounds. Now, in building works, it is understood by the manufacturer of gates that we have to have a gate to stand the same pressure as the pipes. Therefore I come to the conclusion that 300 pounds is what it is expected these gates will stand. We are liable to water ram; they are unaccountable but we all know we have them, and they come under peculiar circumstances at times. I have gates from one inch to thirty-six inches under a standing pressure of 110 pounds—that is, the working pressure every day—and I think we have water rams that carry it up to unknown pressure. I do not think we are able to tell what it is, but I do believe that these gates should stand at least as much as the pipe will. I have never had a gate to burst on the works, so I cannot give any experience on that point.

MR. JONES:—What pressure do you say you work under?

MR. DARLING:—The pumps work under 110 pounds pressure.

MR. JONES:—On a thirty inch pipe?

MR. DARLING:—Yes, on thirty-six. On the new works put in last year I have thirty-six inch force mains. We run up at times to 120 pounds pressure on the pumps when pumping 12,000,000 gallons.

MR. JONES:—That is a part of the information wanted in this case—that is, the experience of superintendents of water works who are carrying a pressure of from 100 to 150 pounds with a large line of pipe subject to water ram.

MR. DARLING:—I may be allowed to explain that while I do not mean to have it understood that I objected to the discussion of this subject in the line it has taken, I did object to this association undertaking to say what in its opinion the liability would be under certain circumstances. Of course, as the discussion has proceeded I can see that we are getting at legitimate facts which every one of us wants to know, as well as the experience of others predicated upon these facts. I understand that is what this association is for—the obtaining of knowledge that can be derived from the free interchange of experience.

MR. POTTS:—There is another matter that suggests itself to me: What were the circumstances under which this valve broke? Circumstances have a great deal to do with it. I believe I can take a 30-inch valve in a shop as ordinarily made by any valve maker and test it to a thousand pounds to the square inch and it will bear it. I will tell you how I would do it. I would put it between two blocks or flanges and subject it to pressure inside with a band hub, and I would think—it is merely my thought—that you could not break that valve under 1,000 pounds pressure. Now, I will take the same valve and test it in the shop at 200 pounds, which would be the ordinary test perhaps of a valve, and I will put it on a pipe and I think I can burst it under 100 pounds under certain circumstances. Suppose you close that valve down, merely close it so it will be tight, and put 100 pounds pressure on the face of the valve; then put a wrench on it and put two men on the lever and turn the screw down, is anybody able to tell what pressure you have on that valve or strain upon the iron? I think it is inestimable.

A MEMBER:—The strain would naturally be on the stem.

MR. POTTS:—No sir; it will be upon the body of the valve.

MR. LINNEEN:—Now, in reply to Mr. Darling, who informs us he has a pressure of 110 pounds and that all valves are constructed to stand 300 to the square inch at the shop, but he informs us that the water hammer is an unknown quantity, and because of that you may subject that valve to any pressure. Now, with all due deference to Mr. Darling's judgment, I think the water hammer is a myth; I don't take any stock in it—not a bit.

MR. DARLING:—I do not believe any man who has had any experience with water works, or the use of water, can conscientiously say that the water hammer is a myth. I do not believe there is a water works superintendent on this floor that will get up and say he does not believe in any such thing as the water ram.

MR. LINNEEN:—I believe in it to a certain extent but not to the extent talked of here. It is certainly an unknown factor, if it is a factor, and so far as it has been preached up here to a thousand pounds, I don't take any stock in it.

MR. DARLING:—I don't deal in extremes, but it is an unknown factor and you don't therefore know whether it is 1000 or not.

MR. LINNEEN:—I take the ground that breakages in pipes are not due to the water hammer. There is no doubt in my mind but that this break is attributable to faulty allignment of the pipe, undue strain on some part of the valves; that is what I think caused it. The setting of the valves and pipes have a great deal to do with their usefulness, and the point Mr. Potts raised is very pertinent—it is very uncertain how much power the lever will exert on the valve. and while I take the broad ground that valves, hydrants, and all other appliances for water works ought to be constructed with the greatest possible care, I will say this, gentlemen, if the men charged with the setting of these valves and laying of the pipes would use half the care manufacturers use there would be very little trouble with their property.

MR. REYER:—As to the water ram there is no doubt about it. One way we can decide it, from a theoretical point of view, is that any falling body will strike a blow harder than if moved against it, and the blow is equal to the velocity multiplied by its weight. Now, water in motion through a pipe ought to be taken in the same way. If we have a volume of water passing through a pipe at a certain velocity and it has a certain weight, and it is put in motion and then suddenly stopped it is bound to strike a harder blow than if merely subjected to a steady pressure and the water not in motion.

MR. LINNEEN:—I would like to ask how he suddenly stops it?

MR. REYER:—By having a valve that you can readily open and close. If you open a valve very suddenly and close it you will notice the gauge will go far above what you are carrying.

MR. LINEEN:—If you turn it off suddenly you will have a water hammer no doubt.

A MEMBER:—I would like to cite a case of pumping through a main a long distance and up quite an elevation where the sudden stopping of the machinery causes a ram. They have two miles of 16-inch main at an elevation of 200 feet nearly, and are pumping about 2,000,000 gallons of water, if they suddenly stop their pumps the gauge at the engine house shows a large increase of pressure due to the sudden stopping of that column of water and its return.

MR. LINNEEN:—That could be remedied by a relief valve.

Mr. Milner:—That reminds me of an instance that occurred in my experience. We operate a Blake engine, and on one occasion a little pin that connected the steam valve dropped out. The engine stopped instantly; just outside of the pump house was a "Y" by means of which the two engines were connected into the same main, and a piece flew out of the "Y" leaving a hole large enough to flood the pump house, I could not account for that break in any other way except on the theory that the stopping of the machinery caused the water hammer. The pump was operating under a head of about seventy-five pounds.

Mr. Hornung:—I had occasion to make practical experiments in that direction some ten years ago. The conditions were something like these: The force main was about 1000 feet in length and had an hydrostatic pressure due to an elevation of 350 feet. The pumping engines could be stopped instantly. Just beyond the check valve I applied an indicator which was operated by clock work, and took from that motion half minute cards. Signals were established between the engineer and operator and the instant the engine stopped the indicator was put in motion and a record made. In the water column I found an oscillation; the pencil making spurs of course at the commencement, which diminished until they vanished almost. This experiment I repeated a number of times, and I was surprised to find the amount of oscillation that occurred in that force main. When I spoke of the water ram a few minutes ago I was aware that all water works had suffered from them more or less and that experience fully confirms it. The water ram I had reference to were these that occur in well designed systems. Now, we have water rams that occur from illy designed machinery, and our valve manufacturers know something of that. I am dealing with just such a case. where I dare not fully open the gauge, for fear it will tear it to pieces. I may tell the valve manufacturer that I have a head of a hundred feet to pump against and that I regard it as a high pressure system and say nothing of this excessive water ram, he would make me a valve such as he did for some one else that he knew did give good results and never gave any trouble, and in the case here, where it is as much as can be done to hold the pipe in the ground the valve would soon go to pieces. Where we meet such conditions we should in all cases get some data from which both the valve manufacturer and the pipe manufacturer, or the pump maker, can understand he is dealing with unusual circumstances and conditions.

MR. LINNEEN:—I don't think we have touched the question in point. Now, on general principles manufacturers are very poor and they sell their goods exceedingly low. Cities that own their water works, and water companies that have good franchises—I am one of them—are rich, and a little advantage of that sort ought not to be taken of the manufacturer.

MR. JONES:—That is the least important point in the question. What we want to know is whether there is any water works in the country pumping through a thirty inch main under pressure above 130 pounds, and whether it is safe to risk a pipe so large as thirty inch under very high pressure? If there is any economy or more safety, in using two pipes instead of one, we want to do that; if we cannot pump with such high pressure through a thirty inch pipe with safety and the assurance that the pipe will stand the pressure, we don't want any thirty inch pipe; we can't afford to have it. That is the question.

MR. LINNEEN:—Here is a new question which is very pertinent—whether it is economy for water works depending on the direct system to use two lines of pipe or one. I believe that is the question Major Jones raised. That is a pertinent and important one for this association to discuss. It is a new question whether it is economy or safe for a city to depend on one line of pipe, whether it is not more safe to have two lines. Well, I should say, of course as a matter of fact that two lines would be safer than one, but there is the question of expense. Now, a question that raises in my mind is whether there is a factor of safety which a corporation will derive from duplicate pipes—whether that factor of safety will warrant the expense, or whether appliances cannot be applied to the system of distribution that will render well constructed thirty inch pipe and its attendant valves and arrangements, safe under ordinary continuous service. Now, about the value of check valves. We have a great many systems of works in operation in the United States, and only in one instance have we a check valve that I know of on the pressure side of the pumps. I think we are pumping at Covington, Kentucky, against 300 feet head without a check valve. Now, it seems to me the safety of the entire distribution of any system of water works depends on appliances and arrangements brought into use for the proper distribution of the water after it leaves the pumps. The question arises, cannot there be mechanical appliances applied to the

power used for distribution to prevent a great deal of this water hammer or back pressure? I contend there can be, and if I wanted to go into this discussion elaborately and so take the time of the convention I could convince you of it. I will answer the question propounded by Major Jones, by saying that a well constructed thirty inch line of pipe properly located, joints well made, valves well tested, and the system put under proper test by the pumps before it is turned over for general use, is as reasonably safe as anything can be made, and that it is just as safe as two lines under the same conditions.

Mr. Nevons:—I have been very deeply interested in this gate question, and I am sorry we have diverged. I have been interested in what the gentleman on my right had to say as to what he has done about pressure on the side of the gate when it is nearly closed down. I had a very peculiar case on our works that I have not been able to investigate. I intend to do it when I get home. We have a line of thirty inch pipe of eight miles; we have a reservoir eight miles out of the city. The thirty inch line runs to the receiving basin and out into the pond when it is turned up and attached to the pump. We have directly on the shore of the pond a thirty inch gate for the purpose of shutting off or controlling the water. When we have the gate almost closed, I have seen the water go down so you could see none coming out, and that gate stops so solid no three men could start it, and all at once the water would go up four or five feet and then a man could turn the gate with one hand and then it would stop again. We have looked it over carefully and gone over the whole line of pipe; it is an undulating line but at no place do you rise above hydraulic grade; we have air valves on all the high points, and at this gate on the pond we have one half inch air valve. I have turned it open but it did not make any difference. The gate goes down until it closes almost and then grabs and holds as solid as a wedge, let it stand a minute and you can get another turn. Probably some of you gentlemen can tell us what is the matter.

Mr. Cameron:—I don't know that I can answer that question, although it suggests itself to me that somebody on the line has opened a large opening and let air into the main.

Mr. Nevons:—There is no opening from the time it leaves the reservoir.

Mr. Cameron:—I once had the same experience in closing

a large valve but found upon investigation that somebody had turned a valve and let in air. Now, on this thirty inch valve question; we have just put in two miles of thirty-six inch pipe, and I agree with Mr. Linneen on this point, that it is necesssary when you build water works to build it so it will conform to the duties required. We have put this main in as we think with extra heavy joints and wherever there was a weak or faulty place in the soil we have put six by eight timbers laid in concrete, so there will be no danger of the pipe settling, and endangering the safety of the valve. I agree with my friend that the valve under certain circumstances may break, when under others it will not. The least little pressure this way or that way in the valve is apt to break it while under other circumstances it will attend to its business all right. So, I say, in order to build water works you must spend money liberally and buy the proper sort of materials, and have them made strong enough. Don't try to jew down the manufacturers; we ought to be liberal with them. but when we have paid them their fair price call on them to make good any defects.

Mr. Linneen:—I will say in answer to the question propounded about the pressure. As I understand it in closing this gate after you get to a certain point you can't turn it any more until a short time elapses and then it closes regularly. The only way I can account for that, is in the action of the pumps. You have duplex pumps with double acting plungers; you get four displacements of water with each stroke. When the water is on its onward course and it strikes the face of that valve there is an extraordinary pressure exerted on the valve at that time and it strikes the water from the pump after the plungers have made their stroke. It is more than the ordinary pressure; there is no doubt about it because it is sent out with some force.

A Member:—Call that water ram.

Mr. Linneen:—No sir; it is the natural pressure. That water recedes slowly and at that time it closes easily. That is the only way to account for it.

Mr. Nevons:—I will say for the information of the gentleman that it is gravity flow. [laughter.)

Mr. Linneen:—The entire circulation may come around and strike the face of the valve.

Mr. Nevons:—Perhaps I don't make myself clear in regard to the matter. We abandoned our old pond converting it into a receiving reservoir and extended our pipes out eight miles to another reservoir; there is not one single tap nor opening on that line, in the whole eight miles. Now, that has a steady gravity flow all the time. The gate is a thirty inch one which we manipulate so as to let in just enough water to keep the pond full. I do not at any time require to have it open more than eight or ten inches by the gauge on the gate; with careful opening of the air valves through the line, doing it myself, and the gate being closed at the time at the pond, and then only being opened eight or nine inches I find this trouble; I cannot remedy it in any other way, to my mind, except by overhauling the gate, and then perhaps I won't find anything. It has been a very serious question with us and we had our Consulting Engineer there. He says there *must* be air in the pipe, but if you close the pipe and go over the air valves with pressure on at the upper reservoir I don't see how it is possible for air to be in the pipe. Now, I have thought perhaps, it being undulating, there might be surjection but I can't see how that could be brought about unless there was a large volume of water used and suddenly checked. I think that accounts a good deal for the water ram. It is not so much the cutting off that has done it as a sort of receding—something like the gentleman last night had it in regard to the meter. I think we all know water is not compressible but still having open ends there might be such a thing as the water surging back.

Mr. Gevelin:—Any gentleman who has observed the water sluices along canals could not fail to notice the undulation in the level of the canal when they close the gates. I have seen it last twenty-five minutes, going backward and forward gradually growing less. When you shut down suddenly in a pumping machine I have seen the gauge vary from 120 pounds up to 160 pounds to the square inch, the pressure gradually becoming less and less. It is an unknown compressible matter being pushed back and forth until it comes to a rest, which at Augusta, Georgia I have seen last twenty minutes.

Mr. Hornung:—That is what I wanted to call attention to—the oscillation of water volumes that occur; I know it does in pipes when the flow is suddenly stopped.

MR. MONJEAU:—This is a matter we have studied for some time in trying to obviate the destruction of railway cars, and I am under the impression that in stopping a long train of cars, we can avoid the breakage, but we have not yet arrived at any way to do it because the first car that is stopped receives the blow of the next with the momentum of the train and the next again and so on. How much that momentum is lessened, or how much it may be increased we are not able to ascertain. The fact that a train of water, so to speak, or a body of water, coming down at a given velocity is suddenly stopped, may have on the valve stopping it the same effect. It is my impression that the same law will apply to water. I know it is the same case with air, and I am under the impression that water vibrates on the same principle. If that be the case it will explain the difficulty that the gentleman speaks of. The weight of the body of water in the pipe is on the valve for the moment. When that momentum is gradually stopped then the valve can be turned without difficulty.

MR. JONES:—This question is to us perhaps more serious than to any other water company in the country. We are now the largest city in the United States pumping water by direct pressure, and when these accidents have happened—whether due to imperfect valves, to water ram or to any other cause—it raises doubts in our minds as to whether we can keep up with the growth of the city with direct pressure. If we cannot do it with safety we must resort to some other method, and it was with that view I wanted to get up the discussion, in order to learn the experience of other people as to whether there was sufficient safety in the direct pressure system in large lines of pipe. We are not afraid of the pipes because they are standard weight and will stand any pressure, and if a valve cannot be made as strong as water pipe we are just about at the end of our rope in keeping up with the demands made upon us. From this discussion I have received considerable information and I am very thankful to the convention. On motion adjourned.

THIRD DAY.

MORNING SESSION.

Thursday, April 18th, 1889.

The President called the Convention to order.

THE PRESIDENT:—The first order of business is the reading of the paper "Standard Water Pipes" by Mr. S. B. Russell of St. Louis.

STANDARD WATER PIPES.

In all probability the majority of water works men and other pipe consumers have now mapped out clearly in their heads the way that the dimensions of a manufactured water pipe are determined. First the engineer, contractor or superintendent, let us call him, this consumer, orders his pipe, giving the inside diameter and the thickness of the barrel or the weight per foot or per pipe. The manufacturer receives the order, calculates what the outside diameter of the pipe would be if of the exact inside diameter required and then looks over his patterns and selects the one nearest to the calculated diameter. If the pipe is a six inch he may have four or five patterns to select from, if it is a twelve inch, he probably has but two. Having chosen his pattern he calculates the diameter of the core which will give him the same weight per foot as the pipe called for.

The result of this roundabout way of dimensions is that we rarely get a pipe exactly twelve inches, for example, in inside diameter and that no two manufacturers will furnish a pipe of the same dimensions. In fact the consumer never knows the precise dimensions of the pipe until it is delivered and measured. There is probably no great loss entailed by this present method although a little annoyance sometimes follows when a new pipe will not slip into an old one or when our special castings do not give the proper joint.

To look at present conditions from another point of view, we find that there are in use in America * no less than fourteen different classes † of six inch pipe ranging from twenty-seven to thirty-three pounds per foot in weight.

This sums like an unnecessary number and especially when we remember that we have to allow manufacturers a margin of from two and a half to five per cent each way in weight and even then they do not seem able to keep within the limits.

In wrought iron pipe we do not find so many classes necessary and the same may be said of lead pipe.

There is room for improvement in our methods or rather want of method.

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* Paper by Mr. Noyes, Trans. New England Water Works Association, 1885.

† The word *class* is used to designate pipe of a certain weight per foot.

To bring about a change we should have the cooperation of manufacturers and consumers and both should be consulted in formulating a scheme. This Association is eminently fitted to lead in such a movement and any well considered plan formally approved by this body would probably come into general use, gradually if not rapidly, as new consumers are starting up all around and old patterns must be replaced by new from time to time.

In getting up a standard series we should first determine the number of classes needed for each size of pipe. Probably five or six classes would be sufficient for any one size. Having determined the average weight per foot for each class we should then agree on the patterns. One pattern would probably do for two or more classes and indeed I am not sure it would not be well to have only one pattern for each size of pipe as this would greatly simplify the *joint* question.

In St. Louis we have four classes of thirty-six inch pipe and two classes for every other size and we use but one pattern for each diameter, so that pipes from the same foundry will fit together regardless of class.

It would not be advisable, in my opinion, to consider any formulæ for pipe strength or to lay down any rules as to the head which any class would safely stand.

The consumer or his engineer should be the one to decide on the strength of pipe needed under given conditions and on the proper relation of thickness to diameter.

THE PRESIDENT:—The subject of Mr. Russell's paper is now before you for discussion.

MR. RUSSELL:—If there is no discussion, in order to get the sense of the association I make the motion that a committee of three be appointed by the president to draft a standard series of pipes, to be submitted to the Association for approval at the next convention.

The motion being carried the Chair appointed Mr. Russell, Dennis Long & Co. and Shickle Harrison & Howard Iron Co., or their representatives.

THE PRESIDENT:—Our next paper is "Relation between plumbers and Water Companies and Departments" by Mr. B. F. Jones of Kansas City.

RELATIONS BETWEEN PLUMBERS AND WATER COMPANIES AND DEPARTMENTS.

This subject is so old and so well ventilated and discussed that it would seem difficult to present anything original. At the same time it is always interesting, and I might say inexhaustable.

The text may properly be divided into two parts:

Relations that ought to exist, and Relations that do exist.

There is not the slightest reasons why these relations should not be perfectly harmonious; the one party exacting only reasonable compliance with reasonable rules and regulations which are undoubtedly necessary for its preservation, and the other by reason of such compliance securing encouragement and assistance from a source of undoubted value.

To a limited extent, plumbers are good men, mechanics of fair intelligence, who want to conform to rules, provided they can do so, but they are often enticed or tempted to do wrong by the flinty penuriousness of the house holder, who, while wanting the best work done, is unwilling to pay for it. It is generally under these circumstances that the plumber shirks his duty, makes trouble between the Water Company or Department and the owner, violates the rules, loses reputation for honesty and integrity.

Again, there are plumbing firms of high standing commercially, who do business on sound principles; who do not care to take a contract unless there is profit in it. These men want to conform to all the rules and value the advantages of the confidence and esteem of the Water Company, but they are handicapped to some extent by unscrupulous apprentices (plumbers, so called) who likewise make trouble and vexation.

All Water Departments, at the begining, start out with a code of rules for plumbing concerning the introduction of water into premises.

First They require a bond, generally covering a period of one year. fixed, in some cases, by a specific sum, or in other cases it is general. intended to cover any losses sustained by reason of non-conformity with the rules.

Second: After the bond has been filed, together with his agreement to comply in all respects with the rules, before doing any work he must have a permit and agree to promptly return the same when the job is finished.

And then came the details as to what may and what shall not be done. for example:

The pipe must be under ground so many feet.

All connections to wrought iron pipes must be made with a tee or cross.

All lead pipe shall be extra strong.

No fixture for ordinary use must be attached to elevator, stand pipe or motor connections.

Stop boxes must be put directly in front of premises to be supplied and not on the line between two lots.

Must not furnish keys to stop boxes.

Must put stop and waste into all premises, that will drain the pipe.

Must put in chambers to prevent the water hammer.

If the use of hose is not wanted, refrain from putting in hose connections.

Must use lead pipe from main to curb; must "wipe" all joints; must not put compression bibbs over sinks or wash basins; must not connect water pipe to privys or any place likely to freeze.

It would be tiresome and unprofitable to follow these details, which are so familiar to you all. It is enough for present purposes to mention these as some of the prominent requirements.

Experience teaches us that the strictest sort of rules are necessary. and the circumstances must be very peculiar which will permit variation: and yet; some of these could well be modified, as an exception to the rule, were it not for the fact that it weakens discipline, demor-

alizes the office force and proves occasion for more frequent and objectable violations in some other directions.

We have found that plumbers, instead of plainly stating to the applicant that such and such appliances will not be passed by Water Company, depend upon the applicant to engineer through the office, by personal appeal or otherwise, an irregularity which they had in their power to prevent. In some instances they proceed to make a connection which they know is not allowed under the rules, and excuse themselves by saying that the applicant has permission from Mr. So-and-So to make an exception in his case, thus throwing all the disagreeable explanation of why and wherefore upon the company. This practice I need not say, is not as frequent now as formerly. In this connection I may mention a case recently brought to my attention. A certain plumber had connected an outside closet with the pipes from the dwelling, with the understanding that the applicant would make it right with the company, his returned permit found its way to the rejected hook, and in turn, the plumber was ordered to take the pipe out. This brought to the front the occupant, who could not see why we could not let it remain during the summer, upon his promise to disconnect it in the fall of every year. The result of the controversy was, he was allowed to let it remain by metering his premises, and the plumber should have been suspended, but in all probability was let go. It would be a hopeless task to convince that householder of the justice of this disposition, and I doubt very seriously if his bills will be as much with the meter as without it. If not, the company is loser, all on account of this violation by one of the best plumbing firms of our city.

No Water Company can afford to be out of harmony with a fairly minded plumber, any more than an evil, disposed plumber can afford to be out of harmony with the Water department. A nice discrimination and sound discretion,—a give and take sort of a way—of disposing of all these questions, is, in my judgment, the wise course to pursue, provided the plumber is not intentionally mean and entirely indisposed or incapacitated for observing the plainest code of laws ever made since the ten commandments were written on the granite of Sinai, in such a case suspension or revocation of the license is the only safe rule of action.

As I have had occasion to say before, "Even a plumber ought to know something about plumbing" and I am free to say that some of them do, but many of them do not. A man may know how to wipe a joint, use gas tongs and red lead, and how to kill time and charge seventy cents an hour from "early morn till dewy eve, and till morn again," and yet fall very far short of being a plumber in all that that word implies. He ought to be a gentleman and a scholar and a judge of the rights of others. I believe they are, however, the best abused people in the whole world. Even an honest and upright man in the profession has to suffer for the short comings of those who are hopelessly insolvent in character as well as in good intentions. No profession, to my knowledge, has such a mixture of very good and very mean people, and a very mean plumber is only excelled in meanness by the charcoal burners of the Iron districts of Hanging Rock, Ohio, and others like it.

While upon this subject I may remind the Association of a paper read at Cleveland, a year ago, by our worthy president, in which was discussed what he chose to call "the Kansas City question." A plumbing firm had rebelled, refused to give bond and, under advice of counsel, did work in connection with water pipes without taking out a permit, but notified us from time to time that such and such work

had been done. Under a city ordinance, for our protection, we could have had them arrested and probably fined for the violation of the city ordinance, but this would only have provoked them to wrath, so, by advice of counsel, we complained to the Circuit Court and asked for an injunction. At the preliminary hearing, we proved by all the plumbers, almost, in the city, that our rules were reasonable and unobjectable, and that these parties were likely to do us serious injury; proved also, that our rules were not unlike those of other companies or departments in any essential particular. The Court, to our surprise, denied the injunction, although it held that we had the right to enforce all proper and reasonable rules for the conduct of our business. The case was without precedent and hence the Court had no benefit from other decisions. We, however, were preparing for formal trial and appeal if necessary when one of the firm applied for a license and gave bond on his own account, which was shortly followed by the other member of the firm, whereupon the case was dismissed at his own cost and now all are happy and serene.

This termination takes the "Kansas City question" out of the courts, leaving, to some, doubts as to the final result had it proceeded, but I am perfectly satisfied that we should and would have had the injunction in due time. The mills of the Gods grind slowly, but in time they grind very fine.

So long as water companies and water departments base their action upon justice and truth they will be sustained by the courts and all good citizens. All monopolies have trouble and vexation and yet, because they are monopolies there is no justification in riding rough shod over their patrons. A monopoly, whether it is a water company or a gas company, or an oil trust or a sawdust trust or any other sort of trust, should never forget that it is dependent upon the community for sustenance and their creation is due to the community and that violation of laws, all over the world, is punished only to the extent that the community is in sympathy with them, as evidenced by the great number of statutes violated every day; not enforced because they are obnoxious to public sentiment.

Let us be reasonable in our rules, exacting no more than actually necessary, be firm in enforcing these, and patiently await the results.

(The reading of the paper was concluded with applause.)

MR. CAMERON:—I think Mr. Jones has covered all the ground, and I do not think he has left a point to discuss. However some gentlemen present may want to discuss the poor plumber; he seems to have no friends.

MR. DIVEN:—We all license and put plumbers under bond. I would like to know if any member has ever revoked such license and collected the amount of the bond. I had occasion to try it once and did not succeed.

MR. JONES:—I have known of frequent cases where they have been revoked, but there is nothing due until some damage is found.

MR. DIVEN:—Didn't the plumber keep right on, notwithstanding?

MR. JONES:—No sir; that was exactly this case I speak of.

MR. CAMERON:—Mr. Diven asked a question which reminds me that I did once have a case where I collected five dollars from a plumber, and the serious part of it was that he was a colored man—one of our poor colored brethren. I disliked exceedingly to have to take the money but as I was instrumental in having the ordinance passed by the authorities then having charge of the City Government. which enforced the penalty of from five to fifty dollars upon any body who interferred with the fixtures of the Water Company in any manner whatever, I had no recourse but to proceed against him. It appeared that the man had very kindly turned on the water for one of our customers who had not paid his bill, and I found out that he had collected the charge of five dollars and continued to keep turning on the water when it was turned off in order to shield himself. That part of the business I did not ascertain until just about the time judgment was given against him. He was fined five dollars in the Recorders Court. On account of the man's color and condition I declined to press the penitentiary offense against him.

MR. POTTS:—There is a case pending in Columbus that involves this question to quite a large extent, the damages sought to be recovered running up in various cross claims from five to fifteen thousand dollars. The case is this: The water works company just prior to this time had revoked all their previous orders of putting in pipe from the curb into the building. That was a habit the water works had fallen into—of taking contracts to put in elevator pipe, but they had ordered the Superintendent not to do any work of that kind. Then the plumber takes the contract to put in elevator pipe and the water works company put the pipe up to the curb and placed a valve there. The plumber goes to work and puts in a lot of iron pipe connected with the valve without putting a collar on it and when the water pressure was turned on, it blew the pipe out. The tenant sues the landlord for ten thousand dollars damages; the landlord comes upon the City for damages by water; the City demurs, saying they had nothing to do with it; that it was caused by the defective work of the plumbers. There upon he (the landlord) turns around and sues the plumbers likewise. The case is still pending and it is a very hard matter to say what the out-come will be. The suit was brought some three years ago and is still working its way

through the Courts. As I have said it is a difficult thing to guess what the result will be, but my impression is that the plumber should be held liable; certainly not the city because it was not their pipe that burst and they had had no hand in doing the work.

MR. CAMERON:—They have an inspector, however, and he should have looked after that.

MR. POTTS:—Well, the Inspector could not be there all the time to see that they were doing the work properly. It appears that when he did pass over the work it looked all right, and it was only when they put on excessive pressure the result showed that a collar had not been put on the wrought iron pipe, which caused it to blow out.

MR. GARDNER:—In New Orleans for some time I had considerable difficulty with plumbers arising out of irregularities practiced by them in their failure to report the work done, until it became a mooted question as to whether a Plumbers Association should not be organized. I fostered that idea and to the best of my ability stimulated that organization after it had been formed, and then I went before it and submitted our proposed rules. They examined them and said they were just, reasonable and proper. I had pledged myself to facilitate and assist them in any manner I could, simply exacting from them a promise that they would conform strictly to those rules and regulations which they had approved, and that they would aid me in tracing out tin smiths and jobbers who undertook to do plumbing work. I am glad to say that since that time I have had comparatively no trouble with plumbers, and when any irregularity has occurred growing out of this unauthorized work I have found the plumbers of New Orleans ready and willing to respond to any call I have made on them to assist me in tracing up these people and bringing them to justice. We are protected by a City Ordinance and so have no difficulty in having the offenders fined when caught—that is in having any man who is detected doing plumbing work without proper authority and license being fined and punished.

MR. BRIGGS:—My experience to a certain extent has been similar to that of Mr. Gardner. I took our rules before the plumbers and told them that if there was anything in them objectionable to point it out. We went all over the ground, and agreed that we would work harmoniously. That

Plumber's Association however broke up in a week, so that we did not derive much benefit from it.

THE PRESIDENT:—I should like to ask Major Jones if he forbids the use of compression bibs over sinks?

MR. JONES:—Entirely.

THE PRESIDENT:—May I ask why?

MR. JONES:—It is because of the likelihood of their being left open and the consequent waste of water. We require self closing cocks in all cases except with bath tubs, and we do not allow hose connections over sinks where they may turn the hose on anywhere.

MR. HOLDEN:—I would like to inquire if any member has experienced trouble by reason of having incompetent plumbers licensed. In our town we made a fight to have a City Ordinance passed licensing plumbers, and after awhile such an ordinance was passed, but it put the license at one dollar. The regular plumbers—we had six or eight of them in the city—were in favor of the ordinance, but the result of it was that every tinsmith and locksmith that could tinker on a pipe took out a license, and thus had just as much right to make repairs as the best plumber in the city, so that that piece of legislation did not help us at all.

THE PRESIDENT:—I take it that it would be much easier to answer the question, what member of the association has *not* had sad experience with incompetent plumbers. As a rule—that is, in the West—we find the plumber is taken from the ranks of blacksmiths, tinsmiths, gas fitters and all sorts of trades, and I am always very weary of a shop where I see emblazoned in large letters, "Sanitary Plumber." I never go into such a shop. Now, I would like to ask what Major Jones does in a case of this kind: Where a man of influence says to the plumber, you do thus and so and I will make it all right, I will stand between you and harm.

MR. JONES:—I think I have explained that in this article. That is one of the very complaints we have to make against plumbers, but generally we make the plumber do the work over again. Sometimes, however, we allow the man to take a meter, but thereby we lose revenue. We don't want meters in private premises. That is the only way we meet the case—either to meter it or compel the plumber to take it out.

Mr. Diven:—In the East we have no plumbers; they are all Sanitary Engineers, but before granting a license to a plumbing concern they must show that they have some one connected with the firm who is a Journeyman Plumber—that is one who has served his time as a plumber.

The President:—We have in our city an ordinance which forbids the use of anything but extra strong pipe from the main to the curb line and it must be laid six feet deep I have never known a pipe in our city laid that depth to freeze. Now, there comes along a genial gentleman who has built a row of cheap houses—say fifteen or twenty of them, and he says, "Can't I have one pipe for all these houses." I reply, "Oh no." "Well, have I got to make a tap for each one of these lots." "Yes." Well, we finally get him to consent to lay pipe for each house. Then says he, "See here, lead pipe costs thirty-five cents laid in the ground and I can get iron pipe for so and so, and it will be a great saving to me to put iron pipe from the main to the curb line; I am building these houses for sale, and it is a great hardship on me to compel first class work under such circumstances." Now, I have never failed to win over such a man by telling him that if it were simply a contract between him and me it would do very well but, my dear sir, you are laying pipe in that ground to stay there for the years after you have not only sold it but are dead, and by permitting inferior work to go into that job now we would be simply entailing an inheritance of trouble on those who follow us. I have never failed to conquer a man by that kind of argument, and assuming a certain kind of positiveness with him. Now, with the permission of the Association, I would like to hear a word from Mr. Nevons of the New England Association. (Applause).

Mr. Nevons:—Mr. President and Gentlemen,—I will occupy your time but for a short space. I wish in the first place to extend a cordial invitation to the American Association to attend the meeting of the New England Association, or rather for the old folks from home to see the boys in New England, and I assure you we will treat you as best we know how. We still have baked beans and brown bread up there and perhaps a change will do you good. We are very much interested in this Association and would be glad to meet all of its members there and have you take part in the discussion on papers that will be read. We have had some pleasant and instructive meetings the past winter, and hold our annual

meeting in June. We have wrestled with many problems, one of which is that of cement pipe, and we have concluded that cement pipe is the best we can have, providing it is made all right, but it takes some one who knows how to make it right. We have concluded that the best way is to have iron any where from seven-eights to an inch thick. (Laughter and applause). There is no trouble about the cement then; you need use no cement at all. (Laughter).

THE PRESIDENT:—There being no further discussion on this point we will proceed with the regular order, which is a paper on "Aeration and Sedimentation of Muddy River Water" by Prof. J. B. Johnson.

PROF. JOHNSON:—When I consented last December, at Mr. Gardner's request, to read this paper before the Association I expected to be able to give results of some interesting experiments I had been making, but up to this time these experiments have not been fully completed. I have been by various circumstances kept from my business for six or eight months, and I am unable to give you a paper which would be really worth the reading. I hope however at the next meeting of this Association to be able to give you something worth listening to. As it is I must beg to be excused from keeping the appointment made for me to-day.

MR. GARDNER:—In the absence of Prof. Johnson's paper I would suggest that the Association ask Mr. Russell to kindly favor us with some description of the contemplated basins at St. Louis—I mean, their general features.

MR. RUSSELL:—I am afraid I cannot give you a very interesting description of these basins, because our plans are as yet very incomplete. We have been studying up the subject of subsidence very thoroughly—as thoroughly as time would permit. We made some exhaustive experiments on the settlement of water in a quiet state; that is, where there was no flow whatever. These experiments have not yet been written up, but my assistant, Mr. Seddon, who is not a member of this Association, proposes after report is made to the Water Commissioner, to write a paper that will be published. I do not care to forestall him in any of his points, and I am not very well prepared for so doing. We have found that constant flow settlement will not compare with quiet settlement in our water, that is, judging from our experiments. The only way is to let the water come to rest and stand perfectly quiet. We have been figuring out the

most economical dimensions of our basins, taking into account, of course the lay of the land and all. The basins we estimate will cost about $1,000,000, and I think ought to handle about 60,000,000 gallons of water a day, and that will give about—I don't remember the exact number, but I think somewhere between twenty-two and twenty-eight hours of quiet settlement. I should like the members of this Association to see our basins. Our present basins have a total storage capacity of 60,000,000 gallons only—that is we have four basins with a capacity of 15,000,000 each and we at times have had a deposit of six feet of mud in them. Our last cleaning however was only about eighteen inches. We clean them as often as we can. One trouble about these basins is that they are too low for the high stages of the river. They are right near the river bank, and to get the mud out of the basins it is necessary to have considerable head to insure a good flow through the sewers that drain the basins and discharge into the river. It is quite a problem how to get up a set of basins that will handle the quantity of water required and at the same time be so arranged that cleaning will be cheap, to remove the large quantity of mud in a few days being one of the requirements and a river having a range between extreme high and low water, of something over forty feet being one of the conditions. I think we will have in our new system about six basins, and that in depth they will be about the same as the present basins—that is, between high and low water will be about eleven feet. Each basin in turn will be pumped full and the water allowed to stand until clear, and then drawn off. In that way we pass around all of the basins, filling, settling and drawing off. This requires of course, quite a complicated arrangement of gates and distributing conduits and these gates and conduits must have a working capacity of 100 millions of gallons per day.

Mr. Gardner:—I would like to ask Mr. Russell if he has decided upon any device for cleaning these basins and ridding them of the sediment.

Mr. Russell:—We have been unable to get any suitable device for cleaning the basins. In our present system we have a travelling syphon pipe six inches in diameter on the division wall between two basins; when we wish to clean out a basin we draw off the water into the pumping system as far as we can and the rest we allow to run out of the waste gate; then start at the lower end of the basin with the syphon pipe

over the division wall. The basin next to the one being cleaned is kept nearly full of water and the syphon pipe gives a stream flowing over the wall and falling on the bottom of the drained basin close to the wall. We then have a gang of men with large wooden scrapers who take a swath, you might say, from the wall down to the center of the basin. The floor of each basin slopes from the north and south walls to a longituditional central *ditch*, running parallel to them and the men work the mud from the wall down to the *ditch* or flume with the aid of the running water and then down the ditch to the head of the sewer, whence it flows by gravitation to the river. We can get the mud out very cheaply; I think we get it out for less than one cent a yard. We cannot very well use horse power in the basin on account of the unpleasant effects that would result from that sort of thing. People don't like to see horse droppings in the place where their drinking water comes from; and we have been unable to think of any mechanical contrivance for doing the work to advantage. When we have only a deposit of sixteen inches of mud it is very quick work to move it off. Sometimes, however, when we have a long stage of high water in the river, and the mud gets thick and deep and hard caked, there is a great deal of trouble; then the mud has to be started by the shovel, the water carrying it away with a little assistance from the men.

Mr. Cameron:—I hate to say anything about it, but I think this question of the settling of water is one that has been settled. I don't think that these expensive reservoirs are necessary when by the simple action of a drill in the earth you can procure water like that. (The speaker exhibited a bottle of clear water). We people at first thought we could not get such water as that, but we have demonstrated that it can be done. Of course I know all these gentlemen must have their plants and use some of their capital on them, but I am under the impression that the best way to filter is to bore for it in the earth.

Mr. Caldwell:—I should, like to ask Mr. Russell what degree of purity he gets—if he has ever looked into the subject of analysis, or otherwise, so as to produce water as clear as that, for instance, (referring to the water exhibited by Mr. Cameron).

Mr. Russell:—Our water after settling is clear enough for nine months in the year to bathe in without discomfotr, but at times the water is very bad; it won't settle. I have

seen the water at times when you might take a bottle of it and let it stand four days and it would look as black as ever at the end of the four days. At these times settling does not accomplish the work at all, but for about nine months in the year the water settles quickly and we get very fair results.

MR. CALDWELL:—The reason I asked the question was, I had an opportunity ot seeing about 150 different waters, ranged like a cabinet, and some of these waters had settled apparently while others that for months, and I might say for years, standing absolutely still in bottles, did not settle.

MR. CAMERON:—Here is a sample of that very water. (Exhibiting a bottle of Wolf River, Tenn., water.) It will stand two months and will still remain just as you see it.

MR. JONES:—I desire to offer the following resolution, "While in no City has the American Water Works Association failed to receive marked consideration and hospitality, it is our pleasure to record the fact that none have excelled the untiring and solicitious attention offered to us by Messrs. Dennis, Long & Co., of this city, extended mostly through their able and accomplished Lieutenant, A. F. Callahan.

The resolution was adopted unanimously by a rising vote Mr. Cameron offered the following resolution, "Resolved, that the thanks of this Association be and are hereby extended to the Louisville Water Company through their very efficient Chief Engineer and Superintendent, Charles Hermany, for the many courtesies shown us, which have so much contributed to our comfort and pleasure during our sojourn in this city."

The resolution was adopted unanimously by a rising vote

The secretary announced that he had received from Mr. Tomlinson of Bombay, India, a communication to the Association on matters connected with the distribution of water in cities, which on motion was ordered to be printed in the report of the proceedings of the Association. The paper is as follows:

NOTES ON SOME MATTERS CONNECTED WITH THE DISTRIBUTION OF WATER IN CITIES.

CONTRIBUTED BY S. TOMLINSON, ASSOC. M. INST. C. E., DEPUTY EXECUTIVE ENGINEER IN CHARGE BOMBAY (INDIA) WATER WORKS.

To the President and Members of the American Water Works Association.

GENTLEMEN: The subject of the Distribution of Water in Cities is a large one and this communication is merely intended to draw attention to a few points connected therewith and to cover drawings of a few of the fittings in use in Bombay.

PIPES.

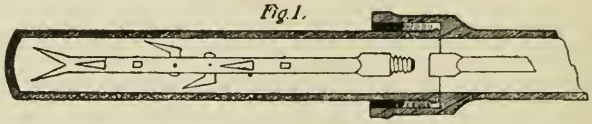
In Bombay cast iron pipes only are and have been used for distribution mains, and generally speaking are of the plain spigot and socket pattern, and are imported. The principal dimensions are:

Diameter of pipe.	Length laid.	Thickness of metal.	Weight per pipe.			Tested to lbs per sq. in.
			c.	q.	lb.	
3 inches.	9 feet.	3/8.	1.	0.	10.	195 lbs.
4 "	"	3/8.	1.	1.	20.	"
6 "	"	7-16	2.	2.	0.	"
9 "	"	9-16	4.	2.	0.	"
12 "	12 feet.	5/8.	8.	3.	0.	"
18 "	"	3/4.	16.	0.	0.	"
24 "	"	3/4.	21.	1.	1.	152 lbs.
32 "	"	1 1/3.	43.	1.	6.	195 lbs.
48 "	"	1 1/8.	64.	1.	12.	"

The durability of cast iron pipes depends upon the quality of the water running through them and the kind of material in which they are laid. The quality of water will be determined upon without reference probably to the lives of the pipes, and the engineer must lay them where they are required. It is desirable, however, to avoid salt earth and economy will justify expenditure to prevent salt earth from coming into contact with the metal. An example of the action of salt earth is found in the case of a 32-inch main on the Bombay works where it is laid, for about two mile, across land washed by the tides. The embankment appears to have been made with earth from the adjoining ground, and in many cases the iron is converted into oxide from one-half to three-quarters of an inch in thichness, leaving a mere shell of solid iron. The pipes are now unable to bear any shock and will have to be relieved shortly. They have been down for thirty years, but they were seriously corroded before they had been laid for ten years.

Corrosion on the inner surface of pipes, due either to deposit of material from the water or to chemical action of the water upon the iron or to a combination of these two causes, may be removed by scraping the pipes. The form of scraper shown on Fig. No. 1 gives good results on small pipes.

Fig. 1.



The scraper is worked by hand, additional rods being screwed on as the scraper is pushed forward. A length of 150 feet can be cleaned in each direction from an opening made in the pipe. One apparatus will scrape three-inch and four-inch pipes, the others being adjustable by means of the set screws indicated on the drawing. The cost of cleansing depends upon the condition of the pipes, and no reliable estimate for general use is possible. A machine (3 & 4 inch) wiih rods complete costs, at the works of Messrs. Guest & Chomies, Rotherham, England, about £12 sterling.

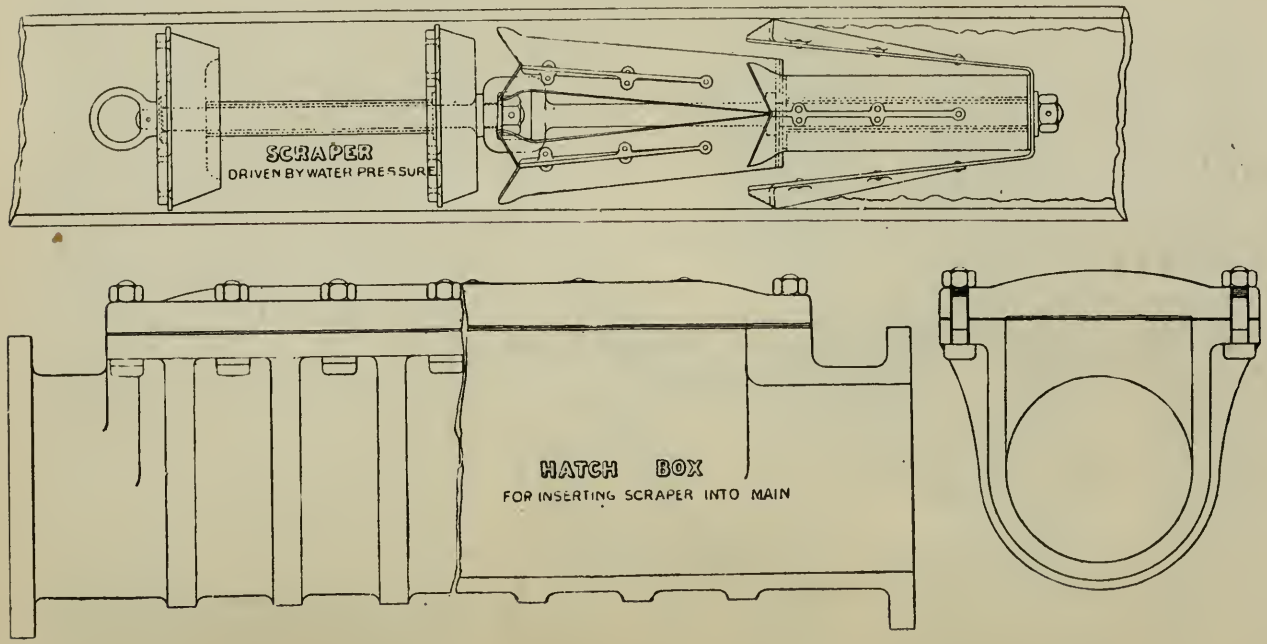
For larger mains and for propulsion by hydraulic pressure the apparatus shown by Fig. 2 has proved very successful. This machine is made by the Glenfield Company., Kilmarnock, N. B., and the working of it is described in the following communication from Mr. Thomas Kennedy, of that company.

EXCERPT OF LETTER OF THOMAS KENNEDY, ESQ., OF THE GLENFIELD COMPANY, KILMARNOCK, ON THE SUBJECT OF SCRAPING WATER PIPES BY HYDRAULIC PRESSURE.

October, 17, 1888.

"In the great bulk of cases the deposit comes from the water. I have seen time after time when nodules were broken off the pipe, the skin entire underneath. An exception to this was Whitehaven, an old uncoated eleven-inch main we scraped was eaten nearly through, so much so that in digging, a man put the point of his pick through. It was scraped to about ten inches, it was not thought safe to do more. The mains in Halifax, Nova Scotia were scraped by scrapers supplied by us and worked by instructions from us. A twenty-four inch at Ronbair, France, has lately been done in the same way, both with excellent results. With large pipes there is no trouble. We have done five-inch but only under very favorable circumstances. I did a seven-inch at Padiham with a four and a half hole through, one-half mile of level pipe to start with, only sixteen feet head. the corrosion was very hard, layers of oxide of iron and sulphate of lime, the summer and winter supplies were different. I got a six-inch scraper down first. Two miles took me a week. Mr. Jamison at one time Assistant Surveyor at Aberdeen did a lot of hand scraping of their small pipes and published the results in a paper read before the students of the Institute of Civil Engineers. London, about six or seven years ago. We carefully weighed the deposit from each eighty yards of pipe. We find that near the junction the corrosion was heaviest. and it lessened as he got to the dead end. We gave one instance

Figure II.


SCRAPER
DRIVEN BY WATER PRESSURE
HATCH BOX
FOR INSERTING SCRAPER INTO MAIN

where there was a long pipe with no services in the centre. There he found the corrosion perfectly uniform. When he got to the service pipes toward the dead end, the corrosion lessened till at the dead end there was none. The pistons of the machine are of steel tapered in front, for an eight-inch pipe the diameter will be about seven-inches. Behind each is a piece of leather backed with lead about one-half to three-eighths inches thick. A certain quantity of water must pass these to carry forward the corrosion, this amount varies according to circumstances. If going up hill it is less than if going down. For an eight inch pipe the average diameter will be seven and a half to seven and five-eighths inches. I heard the scraper at Oswestry where the pipe was sixteen feet under the road, but I could not tell to a few yards where it was. In a three feet cutting I can tell to six inches where it is. Where possible I work it thus. I go over the ground and make myself acquainted with the tract. If there are dykes or hedges I make provision to get across without delay. I lay four men thirty to forty yards apart with an ear to the ground. The orders are, I walk with the scraper, you wait till it comes to you and just passes you, point to where it is, then rise, run to thirty yards in front and repeat. I then get the man at the valve to open to an extent to make the scraper travel about but not over two miles per hour.

The following are the results of cleaning a few mains:

Place.	Size of main.	Length.	Increased delivery.
Bradford, Eng.,	18 inches.	5 miles.	88%.
Lancaster, "	7 "	¾ "	56.5%
Oswestry, "	7 & 6 "		54.4%
Consett, "	12 "	5½ miles.	½ mill. galls. daily.
Exeter, "	10 "	2 "	159,000 " "
Omagh, Ireland,	6 "	2½ "	260%
Aberdeen, Scotland,	3 & 4 "		107%

Where the renewal of pipes is expensive, and the disturbance of street paving is a serious item of expense, scraping will postpone the evil day of renewal for many years, and, once the hatch boxes have been fixed, can he expeditiously and cheaply done.

The catalogue prices, subject to a variable discount, are:

Size in inches.	6	9	12	16	18.
Price.	£9	£13.10.	£18.	£24	£27.

The author considers it a great mistake to introduce a large number of sizes of pipes into any system of water works for the following reasons:

I. The use of any particular diameter necessitates the keeping in stock of sets of special castings of every kind for that size, and also of sluice valves. The consequence is that, on extensive works, there is a large dead stock to be kept which is only occasionally wanted. As large a stock of valves and special castings is required to deal with one mile of main as with four miles, if there be fair facilities for replacing articles as used.

II. It will prove in practice in nine cases out of ten that no Engineer, however able, can foresee within fifty per cent the quantity of water ultimately required in a district; and hence there is no advantage in proportioning the pipes to every one inch in diameter.

There appears to be no sound reason why there should be other sizes than three inch, four inch, six inch, nine inch, twelve inch,

eighteen inch, twenty-four inch, thirty inch, thirty-six inch and forty-eight inches, in distributing mains. The following table is compiled from Fanning's "Water Supply Engineering" and Trautwine's "Hand Book." The cost in other places can easily be ascertained and inserted instead of the figures here given.

Diameter.		Diameter.					
3 in.	:	4 in.	: :	100	:	205	Discharging capacity.
				100	:	158	Cost.
4 in.	:	6 in.	: :	100	:	275	Discharging capacity.
				100	:	137	Cost.
6 in.	:	9 in.	: :	100	:	276	Discharging capacity.
				100	:	?	Cost.
9 in.	:	12 in.	: :	100	:	205	Discharging capacity.
				100	:	?	Cost.
12 in.	:	18 in.	: :	100	:	275	Discharging capacity.
				100	:	175	Cost.
18 in.	:	24 in.	: :	100	:	205	Discharging capacity.
				100	:	144	Cost.
24 in.	:	30 in.	: :	100	:	174	Discharging capacity.
				100	:	151	Cost.
30 in.	:	36 in.	: :	100	:	158	Discharging capacity.
				100	:	?	Cost.
36 in.	:	48 in.	: :	100	:	205	Discharging capacity.
				100	:	?	Cost.

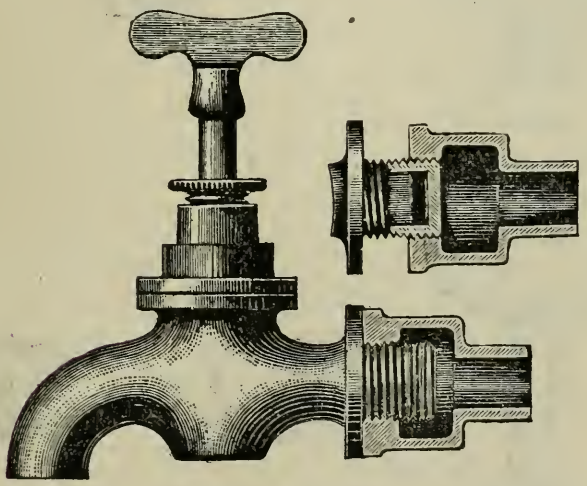


Figure III.

There is therefore always a strong reason for an Engineer laying down a larger rather than a smaller pipe and the usual tendency is for increased sizes to be required.

The above table does not indicate the whole of the advantage, for as a rule, the incrustation is equal in depth of all sizes and hence affects the discharge much more seriously in small than in large pipes.

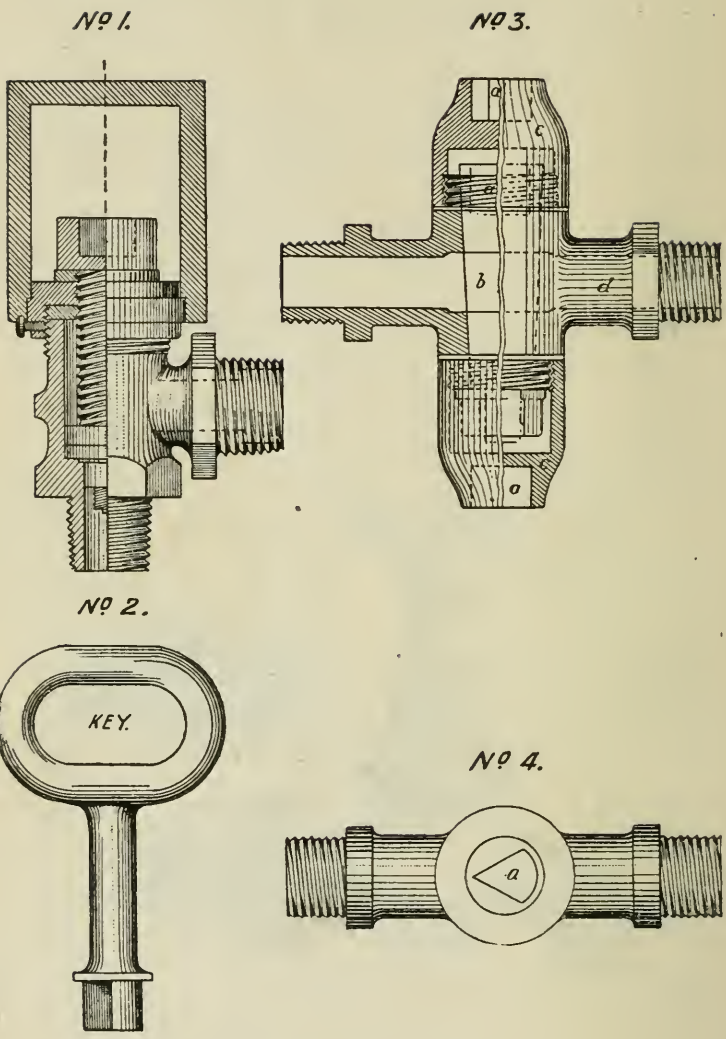


Figure IV.

Except in cases under, say six hundred feet in length, it is not advisable to lay down less than four inch pipes. The main reasons for this are:

First: A three inch pipe is almost useless for fire purposes.

Second. A three inch or smaller pipe does not admit of being bored out to a size sufficient to admit of the insertion of the larger sizes of ferrules for house services.

As short lengths of double spigot pieces have a tendency to accumulate during the progress of works it is well to have the special castings made with double sockets. The use of these will absorb the surplus double spigot pipes and a special with double sockets can be made much shorter and therefore much lighter and cheaper than a spigot and socket special. For repairs a double spigot pipe *i. e.* a plain cylinder say four and a half inches shorter than the usual pipe (socket not measured) are convenient and economical.

The Fire Hydrant in use in Bombay has an outlet two and one-half inches in diameter and gives fairly satisfactory results. An obvious improvement required is the attaching of the valve to the spindle and a guiding shield on the under side of the valve.

Drawings of stop Ferrules; stop taps; and bib-taps in use are appended. They are almost self explanatory.

The stop ferrule used with a Penny's Drilling and Tapping Apparatus (Maker R. Harlow. Stockport, England) allows a main to be drilled, tapped, and the ferrules inserted without shutting off the water.

The Ham's patent bib tap allows of repairs without shutting off the water. The tap being unscrewed three turns brings the "ports" within the screw-thread and so the water is shut off.

The use of the stop tap of the above pattern will at most be confined to localities where there is no port. The only variation from an ordinary plug tap is in the movable caps, which reduce leakage if the plug gets out of order, and in the key required for opening.

One key opens every tap, of whatever size, but in the absence of a key the tap cannot easily be tampered with. The following note explains the reason for its adoption in Bombay.

[*Note.*—There is no frost in Bombay. The service pipes are of galvanized iron, and except in the roadway are very frequently laid above ground. The roads are entirely macadamized and there is great trouble in keeping the stop tap boxes at the proper levels with the change in level of the road surface due to wear and tear. The boxes also rapidly get covered over with mud and dust and this causes much delay and extra expense in making inspections. The tap shown in Figure IV, Nos. 3 and 4, was therefore designed by Mr. Tomlinson and has been in use for some time to obviate the use of stop taps under the road. The new pattern tap is placed at the side of the road, usually against the plinth of the house. The whole city is under the waste prevention system with Deacon's meters.]

The Author does not know how far American offices are in advance of many Eastern offices in the possession of and keeping up to date of correct plans of all water mains, showing the positions and sizes of the Sluice Valves, Fire Hydrants and Meters, with a record of the dates when laid or fixed. Having however felt the want of such a record he mentions it to brother officers who are laying down new or extending existing works.

THE PRESIDENT:—The next business before the Association will be the reading of a paper on "Purification of Water

for Boilers" by Mr. F. W. Gerecke. Mr. Gerecke was unable to be present and sent his paper to the Secretary to be read to the Association.

The Secretary read Mr. Gerecke's paper, which is as follows:

PURE FEED WATER FOR BOILERS.

How happy we and many others would be, if we always could have absolutely pure water for our steam-boilers, so that after months or years of usage the inside of our boilers would show yet a clean metallic surface.

But how sorry would others be if this was the case; the men, who not only make a living but something more besides out of the chemical concoctions and mechanical devices for the prevention of scale or for the removal of scale in the boilers; and another number who are waiting for the orders to renew boilers, which were burned, used up, or entirely petrified in the course of a few years.

But looking at it from the stand-point of the engineer, who has to take care of a set of boilers, what is the best thing to do to keep the boilers clear?

The best thing is to keep the mineral stuff, which may form scale in the boiler, out of the boiler. Get rid of it from the feed water, before it enters the boiler; and if it is impossible to make the water perfectly pure, take as much as possible out of it.

Knowing the water is hard and will form scale, and knowing that there are ways and means to take out at least a great part of the mineral substances from the feed water, why not do it?

Muddy water should never be used in that condition for feeding steam-boilers; but it is being done.

I have seen a new stationary locomotive boiler in a brick-yard used up in four weeks. The whole firebox was burned out, because the engineer, if that man can be called by such a name, had never cleaned the boiler, knowing that the feed water was thick with mud sometimes.

At another time a boiler was brought to the shops with the request to put new tubes in it, when we found that the whole nest of tubes was solidly imbedded in scale, and of course the boiler was useless.

In the upper peninsula of Michigan I saw steam-boilers thrown out of use because there was thick scale all over tubes and shell, which could not be removed. The scale had formed from feed water, which was pumped from hematite iron mines and which was mixed with the colored water from the concentrating works in which particles of jasper and iron ore were yet suspended.

Certainly muddy water should have time to settle, or it should first be filtered and purified.

There are filters and purifiers of different construction.

Filters alone do not take out the mineral solutions. To do this the feed water has to be exposed for a time to the heat of steam, which should have a pressure of sixty to seventy pounds above atmosphere.

There are purifiers, in which the feed water is slowly running in

thin sheets or with a large exposed surface through a steam drum connected with the boiler, and in which most of the lime and its combinations and other substances are deposited on the surface of these pans, from which, after it has formed scale in different thicknesses, the hard matter can easily be removed.

Or there are other devices, as settling chambers or basins, connected with the steam-space of the boilers, from which the mineral substances can easily be removed by blowing off, without much loss of water or heat.

Other devices are arranged inside the boiler, where the feed water is fed directly in the steam-space and the mineral particles float as scum on top of the water, and can be blown off by a surface blow. But very often the particles will settle down, and coming in contact with the hot flues or with the hot shell of the boiler will adhere to them; or if we look at it, that every little particle of water, when ready to go into steam, takes the required amount of heat from its neighbors and a little more from the hot tube and ascends as steam, leaving just a little dot of lime behind on the tube, only to mark the spot from which it ascended—and so with the others—little by little the scale forms, it grows thicker and thicker and the harder for the heat to get through to make more steam, and the worse for the coal pile.

But why arrange the purifiers inside the boiler? Why not leave them outside? If it is an object to prevent scale in the boilers the difference in cost to put an effective purifier outside—only connected to the boiler, should not be a reason to use one a little cheaper, but not as good.

I have watched two boilers which were perfectly alike and new, with a good sized mud-drum on each. One boiler had a purifier attached, which was situated inside the boiler right on top of the tubes, the feed water being pumped through a heater and through the purifier into the boiler, near the steam-space. The supposition was that the lime should accumulate in this box and should be blown off by a separate pipe—but through the same pipe by which the water entered.

The second boiler had no purifier attached, but received the feed water through the mud-drum.

Several trials were made. The boiler, which had the purifier attached, had scale all over the tubes and shell, while the other boiler had only some mud in the mud-drum.

The result shows that the superheated feed water in one boiler has the particles of lime ready to adhere to any hot surface. Both boilers were treated alike with a dose of fluid boiler-compound, which may have had something to do with keeping the minerals in the form of mud in the second boiler.

These boilers were used in day time, carrying a pressure of ninety to ninety-five pounds of steam, while during the night the pressure was reduced to about twenty-two pounds for some low pressure engines. It is claimed that the scale got into the boilers with the water evaporated during the nights when the low pressure, twenty-two pounds, was not high enough to separate the lime from the water. But as we could not change our arrangement the purifier did not do us any good.

When scale has formed in the boilers the question is; how best and easiest to remove it.

If boiler-compounds are used they must not act so fiercely that the scale comes off in large patches which fall down and accumulate

generally in the places exposed to the hottest fire, and cause trouble. I have seen a nice boiler burned in a few hours; a large depression over the fire was caused by a few pails full of scale having settled over the fire sheet. The boiler had been dosed with some highly recommended compound.

That accident settled the compound.

The compounds, which dissolve the scale and make the water appear muddy, and which do not loosen the scale in big flakes, and which do not hurt the metal—may be considered the right kind to be used—but which are they? What is in the compound?

There are many ingredients in them: the agents and the patentees will not tell, but all claim that there is no acid in the compound that will hurt the boiler, and also they state, that the same compound will not soften any or all scales. Decoctions of woods, gums or vegetables are recommended and used; the only thing is to try carefully any or all compounds and note the effect.

If an accurate analysis of the feed water could be had it may point out what ingredients there ought to be in the compound.

The question of purification of feed water for steam-boilers, is not yet solved; it should require great attention by chemists to find some universal remedy. Failing in that we may look to some other quarter—electricity.

This power is brought into requisition to solve hard problems; why should there not be some method either to purify the feed water—or to keep the scale from forming in the boiler by the use of electrical currents?

THE SECRETARY:—It will be observed in the paper just read that the author refers to the use of electricity, and as Mr. Bull, of Quincy Ill., who is present, has been using electricity for the prevention of scale in boilers. I would suggest that he be requested to give us the results of his experience in that direction.

MR. BULL:—The device that Mr. Decker has reference to may not properly be called an electric device. The operation is that of magnetism rather than electric current. The apparatus is quite a simple one. It consists really in making a boiler or battery of boilers the armature or keeper of an electro horse-shoe magnet. I have one core of an electro magnet inserted in the steam dome of one boiler the other in the mud drum. The two cores are connected by an iron yoke as in the case of any electro magnet, and the magnet is excited or operated by a current from a small dynamo run by a water motor. I have had that apparatus on a battery of two boilers for two years and a half. Previous to its use we were greatly troubled by the formation of scale, but since I have had it in use our boilers have been as clean as the back of my hand. I had no thought of speaking to you about this matter but the concluding paragraph of Mr. Gerecke's paper suggested it, I presume, to Mr. Decker who

has, I believe, seen it in operation, and I take pleasure in describing it to you thus briefly, if indeed it is of any interest to you.

PROF. JOHNSON: —May I ask what the theory of this device is, or is there any formulated theory of it?

MR. BULL:—My theory—and I may say I subsequently submitted the theory to Prof. Elisha Gray, supposed by some to be the real inventor of the telephone, at all events a prominent electrician—is that by rapidly interrupting the current which excites this horse shoe magnet the shell of the boiler and the flues are thrown into a sort of tremor or quiver—a vibration. These terms are rather gross to apply to the actual operation; but being polarized and depolarized many thousand times perhaps in a second, the operation is absolutely one of infinitely fine and delicate vibration which prevents the deposition of particles of mineral matter just as a grain of sand on the vibrating head of a drum has difficulty in finding lodgment or rest. I don't pretend to be able to defend that theory as I have no reputation as an electrician that justifies me in even advancing the theory. I simply say that Prof. Gray endorses it as probable.

A MEMBER:—Where does the scale deposit itself?

MR. BULL:—The scale does not deposit itself. There is no scale worth mentioning. The boilers are substantially clean. I take it that what would deposit as scales passes into the mud drum and passes off as mud would be passed.

A MEMBER:—You feed into the mud drum?

MR. BULL:—Yes.

A MEMBER:—Is the water clean?

MR. BULL:—The water is usually moderately clear. Though, the river is turbid at certain seasons of the year for a short time, but our storage capacity is such that we are not obliged to pump at such periods and we do not undertake to pump anything but reasonably clear water. But it is true that most steam users are using one device or another to rid themselves of scales. I suppose it took about an hour to put the thing on, and it has been there for two years and the boilers are clean.

THE PRESIDENT:—Is it a patented device?

MR. BULL:—I did patent it but never offered it for sale.

MR. RUSSELL:—I would like to ask if there is any steel in this boiler or would it affect the problem at all?

MR. BULL:—No, sir; they are iron boilers. I should not think the operation of the device on soft steel boilers would be otherwise than on boilers of soft iron except that the soft steel would not become permanently magnetized. It may interest the gentlemen to know that during the operation the entire battery is distinctly polarized so that any simple test with a compass underneath shows plainly that the whole battery is obviously polarized; it is a guarantee.

MR. CALDWELL:—I would like to ask Mr. Bull if from his experience he thinks the same apparatus would be applicable to all waters and boilers?

MR. BULL:—I should hardly like to venture an opinion on that, because my experience has been confined to my own boilers, and the opinion of any gentleman present would be as valuable on that point as mine.

THE PRESIDENT:—Could that be operated with the ordinary electric lighting apparatus?

MR. BULL:—Yes, it could be operated with any current of moderate strength. I happened to have a little motor and a small dynamo which was built for the purpose, in my engine room, and I operated it by water power.

MR. DECKER:—About what is the approximate cost of such an arrangement?

MR. BULL:—To get it up? I think I paid $25 for the dynamo which furnishes the power, but that was before the general introduction of commercial electricity, you may say. Ordinarily in cities where there are electric light plants and incandescent plants especially, a wire could be introduced into a boiler house without the purchase of a dynamo being necessary. The balance of the apparatus, I suppose might be gotten up at any machine shop by any body who knew how to wind an electric magnet, for five or six dollars—three or four hours of machine work upon it perhaps and a little copper wire.

A MEMBER:—Do you use a water motor for driving the dynamo?

MR. BULL:—I do, because it was convenient. We have no shafting in the pumping station and it is the only method I have got.

THE PRESIDENT:—Do you think it can be used without detriment to the life of the boiler?

MR. BULL:—I have no reason to suspect that the boilers are impaired by its use. In fact I should think since the shell and tubes are kept perfectly clean it would promote the length of life more than possibly something corrosive. I have been using it for three years. My boilers are regularly inspected and pass the inspection in good shape.

MR. DECKER:—I understand then that a simple ordinary incandesent lighting wire would answer the same purpose.

MR. BULL:—Yes, of course, the electrician knowing what current he was going to use.

MR. DECKER:—Your motor is an ordinary sewing machine motor?

MR. BULL:—Yes, I take it to be a sewing machine motor—a little bit of motor.

MR. LINNEEN:—This appears to me to be the most important subject that has come before the convention, and if it is in order I would like to offer a resolution looking to the appointment of a committee to investigate it.

THE PRESIDENT:—It would be in order.

MR. LINNEEN:—Then I move that the Chair appoint a committee of three to investigate the merits of this device and to report to the next meeting of this Association. I make this motion because, as I have said, in my opinion this is the most important subject that has come before this Association since its organization. If the scales can be eliminated from boilers and from the feed water of boilers by a device of the sort spoken of, it will certainly prove a very important matter.

The motion was put and carried unamiously, and the Chair announced that the Committee would be appointed later in the day.

MR. BULL:—As this matter seems to be exciting a good deal more interest than I had any idea that it possibly could I wish to say another word here. I do not wish to pose before this Convention as a distinguished inventor or discover who has brought something new to the notice of mankind. The principle involved is not my own invention nor

idea. I simply improved in my device upon an apparatus which was brought to my notice by a citizen of my own place —an apparatus which purported to employ this principle of magnetism to accomplish, say, this same purpose, but which was applied in such an imperfect manner, namely, on the inside of the boiler by means of a device which was immersed in the hot water and steam, and which sat upon the tubes, and which was thereby rendered of very brief duration. After observing the successful operation of this device, while it continued to work at all---while it was in working order which was perhaps a week or two—it seems to me, the principle, being a correct and efficient one, might be applied in such a way to the boiler that the device might be successfully and easily applied. That is all I have done in connection with it, and the making of a little machine which accomplished the purposed and preserve its original integrity. That much I have done, but I wish to distinctly disclaim that I am the inventor or discoverer of the principle.

Mr Decker:—Do you find it necessary to keep this in operation all the time?

Mr. Bull:—No, sir, I do not. It operates perhaps half the time that the boiler is in operation. Some times I notice it in operation and sometimes I see that it is not. And I will state further—you may be interested in knowing this—it does not embrace the mass of the battery of both boilers between the poles; it is applied simply upon one boiler; it includes between the poles and in the magnetic field simply one boiler. The boiler which sits next to the one at which it is applied is connected, of course, with the usual steam and water connections, but the application of this magnetic principle is made simply to one of the battery of two boilers and yet both boilers are frequently affected equally. There is no conspicuous difference in the operation of the appliance; they both share the benefit, although the apparatus is applied directly to but one and the other has simply the usual steam and water connections.

Mr. Hermany introduced to the Convention Mr. Charles R. Long, President of the Louisville Water Company, who briefly welcomed the Association in the name of his Company.

The President replied in behalf of the Association.

The Secretary presented to the Association the report of

the Committee appointed to draft resolutions in regard to the death of Mr. Harvey F. Gaskell as follows:

Whereas, In the order of Nature our friend and associate, Mr. Harvey F. Gaskell, Vice President and Engineer of the Holly Manufacturing Co., has been taken from us in our mundane activities through death, our common transition and heritage; therefore,

Resolved, That in this seemingly untimely dispensation of Providence, the Engineering profession, the the American Mechanical-Industrial Enterprises, and this Association have sustained a great loss, being thereby deprived of the full fruitage of a growing man possessed of the rarest endowments and highest attainments in his chosen profession; who, had he remained with us longer, would have done more than simply filled his place in the front ranks of Inventors and Constructors.

Resolved, That in the brief business career and shining example of the deceased, we have a heritage, which, in blessings, is second only to his modest and incessant industry and great foresight in devising means for the betterment of our condition while among us, and which we cannot too highly prize.

Resolved, That we extend to the family of the deceased our sympathy in their great bereavement.

Resolved, That this tribute of our esteem for the grand character of the deceased be spread upon the records of this body. And that engrossed copy be transmitted to his family.

Charles Hermany,
A. N. Denman,
B. F. Jones.
Committee.

Mr. Linneen moved the adoption of the resolutions and said: It seems to me proper that I, who have been associated with the deceased for many years in the various fields in which he had labored, should make a few remarks expressive of sentiments proper in moving the adoption of these resolutions. By the death of Mr. Gaskell, the profession of Engineering has lost a shining light. His was an active mind, a mind given to inventions, and while he has not met with this Association in their deliberations in the past, still the public reports that have emanated from the Association from time to time had been his study and pride. He read them with great care and attention, and discussed the merits of the papers that appeared with myself and others at various times. He took a great pride in this Association and looked forward to the future confident that entire success would crown the efforts of the enterprise in which it has embarked. The death of Mr. Gaskell was not only a local loss, and a loss to the Company he so ably represented, but I affirm that

it was a loss to the American people. He had risen to that point in his profession where mechanics and their appliances were fully within his grasp, and it is the universal judgment of those who knew him well that if he had been spared for ten or fifteen years longer it is problematical as to the degree of perfection he would have brought Mechanical Engineering to. Mr. Gaskell had one characteristic that showed itself all through his life, which I think commends itself to all thinking people, and that was, that he rarely followed in the tracks of others. I mean he never availed himself in any of his designs of the work of the brains and fertility of competitors. He was essentially a leader in his profession. Notwithstanding the patents of one of the standard engines of this country had expired some years before, when he was in the field struggling for a competence in his profession, he boldly launched out on a chosen path of his own, and never once availed himself of the advantages that perhaps he might have secured by taking possession of these expired patents. He was original in his designs, and those who are conversant with the products of his brain will bear me out in saying that all of his productions and all of his inventions have worked successfully from the start. Personally I feel a great loss in the sudden taking off of my friend, Harvey Gaskell but my private considerations must sink into insignificance when I reflect that in his death there was sustained a loss which I claim is national. I feel very grateful to this Association that they have seen fit to take this appropriate notice of his death and I shall carry with pride to his bereaved family the kindly expressions included in these resolutions.

Mr. Hermany:—Mr. Chairman, I desire to add one word. I fully concur in what has been said regarding the character of Mr. Gaskell, and while I met the gentleman but twice and did not know him very intimately, I think it proper to call the attention of this convention to the fact that Mr. Gaskell brought the horizontal pumping engine to a degree of perfection which has not been attained by any other make of horizontal pumping engines. That, it seems to me, is one of the crowning glories of his brief business career. In the next place he had been engaged during the last two or three years of his life in perfecting or in contriving a vertical pumping engine, which has unquestionably great merits and promises to be a great success. It is to be hoped for the benefit of the profession in the country at large, that before his death he had so far perfected the design and the details

thereof as will realize the fruits of his labors, in a perfected vertical pumping engine that shall have merits as great as that of the horizontal engine which he did live long enough to perfect. I wish also to say that this example and career are such, as to command my greatest—my unbounded admiration. Mr. Gaskell was an exceedingly modest, retiring and unobtrusive gentleman, a character which to an ordinary observer seemed almost incompatible with the great force that he exhibited in certain lines of mechanical contrivances, improvements and inventions. In his untimely death we have sustained an irreparable loss, and one of my deepest regrets is that I did not have opportunity to know him better. It gives me a mournful pleasure therefore to give this public testimony of my great appreciation of that modest and deserving gentleman, Harvey F. Gaskell, a man who started from the humble station of a country boy, coming to the city of Lockport, and as a boy intruded his presence into the works of the Holly Manufacturing Company at the hazard of being ordered out, impelled to go there by his love of mechanics and mechanical constructions; who afterwards attained in that City, not a liberal education, but a good academic education; obtained employment in that great enterprise of which you are fully informed, and by degrees rose step after step to the important and next to the most prominent position in the conduct of the affairs of that Company. His was a career that is to be envied by any young man of rarer and better opportunities than Mr. Gaskell had, and worthy of emulation by all of the profession.

The President:—Permit me to add that the life of Mr. Gaskell was an inspiration to mechanics every where, that he is entitled to the gratitude of all communities and people who live by means of force pumping. He was the peer of Fulton and Stevenson and Ericson. I will ask you now, in taking the vote on these resolutions, to remain standing until the fall of the gavel.

The resolutions were adopted unamiously by a standing vote of the Association.

Adjourned.

AFTERNOON SESSION.

The President after calling the meeting to order presented to the Committee a letter from Prof. A. R. Leeds, enclosing his paper on "The Hardness of Water," and regreting his inability to be present to read it.

Mr. Darling moved that the paper be published in the report of the proceedings as though Prof. Leeds had read it before the Association.

The motion was unanimously carried.

THE HARDNESS OF WATERS.

The great majority of natural waters form scale when used for feed for boilers. Those that are soft, that is, those that contain so little lime and magnesia that they do not precipitate the fat acids of soap, usually form no more scale than is gotten rid of in blowing off at proper intervals. Sometimes, however, by mere concentration of the mineral constituents, very soft water may give scale. For instance, the waters of the Hackensack River, which is supplied from a drainage area of alluvial land where limestone rocks do not occur, are very soft. They contained on the 3rd of May, and 1st of April of the present year:

	May 3rd.	April 1st.			
Total Solids	3.09	3.67	grains	per	gallon.
Mineral Matters	2.10	2.80	"	"	"
Hardness	1.34	1.8	"	"	"
Alkalinity	1.9	2.5	"	"	"
Common Salt	0.22	0.26	"	"	"

But a vertical boiler which has a large number of short narrow tubes projecting radially, and exposes a large heating surface with slow circulation of the water therein, after running for six weeks upon the above water, exhibited considerable scale. At the end of this interval, the water taken from the boiler had the following composition:

Total Solids	100.02	grains	per	gallon
Mineral Matters	83.93	"	"	"
Total Hardness	15.5	"	"	"
Permanent Hardness	13.75	"	"	"
Temporary Hardness	1.75	"	"	"

By the concentration of the very small amount of gypsum, the boiler water had finally reached a point at which scale was deposited in a boiler of this particular pattern.

The tendency of opinion and practice is against the use of the secret compositions which are offered to prevent boiler incrustation, and

towards the removal of the hardening constituents from the water before it is introduced into the boiler. This tendency is exhibited in a report made by the Associated Boiler Inspection Companies of Germany, and quoted in the "Engineer" of November 5th, 1886, where it is stated that the Association, after having chemical analyses made of all these secret compositions, recommended, that none of them should be used.

To remove the scale forming constituents from water, there are only three substances which are cheap enough and efficacious enough to admit of their general use. They are caustic lime, caustic Soda and Soda Ash. The innumerable other substances which have been proposed, and from time to time used, are either no better, or if better, are too costly. For example, Yrisodium phosphate does not give better results than Soda Ash and is more expensive. Baryta and the soluble fluorides are good precipitants in certain cases, but their cost is prohibitory.

Very fortunately that portion of the hardness which is temporary, that is removable by mere boiling, can be entirely done away with by the addition of caustic lime. If a particular water is affected by temporary hardness only, that hardness may amount to a high figure, and yet be cured by lime at small cost. Even if water has, as is usually the case, some permanent hardness also the great gain at small cost of removing the temporary hardness is such, that this part of the softening may be advantageously carried out, while the permanent hardness is allowed to remain. For instance, the water of a large city in the West has a permanent hardness of 2.91 grains and a temporary hardness of 4.68 grains. By the addition of three grains of lime to the gallon, the temporary is removed, or in other words, much more than half of the scale forming constituents. Moreover the addition of lime does not affect the taste of the water, since if added properly the added lime is removed along with the temporary hardness and the softened water is rendered more suitable both for drinking and boiler use.

But the permanent hardness is due principally to the presence of sulphates, such as gypsum, which are most economically treated by the addition of soda, and the resulting sulphate of soda remains behind in the softened water and affects its taste. For example, the water of another western city has a total hardness of 7.76 grains, of which 1.86 are permanent and 5.7 grains are temporary. By adding a little more lime per gallon than in the preceding instance, the temporary hardness is removed. By adding with the lime the requisite small amount of soda, the permanent is also destroyed, the final total hardness being only 1.7 grains. For the reasons above given, however, it is better to use lime only for the general town supply.

As an illustration of the application of this method, I append the analysis of the water of Champaign Ill., as I found its composition to be in the month of April, 1887.

Free Ammonia	0.07	grains per gallon
Albuminoid Ammonia	0.015	" " "
Oxygen required to oxidize organic matters	0.297	" " "
Chlorine	0.204	" " "
Nitrous Acid	Trace.	
Nitric Acid	0.036	" " "
Total Hardiness	11.08	" " "
Permanent Hardness	7.28	" " "
Temporary Hardness	3.80	" " "
Total Solids	23.91	" " "

Mineral Matters	22.62	" " "
Disolved Oxygen per liter	1.13	Cubic centimeters.
" Carbonic Acid	2.27	" "
" Nitrogen	15.00	" "

This water was taken from a pond with a limestone bottom and was highly calcareous. On storage in an elevated reservoir its taste and smell became very unpleasant from the development and decay of aquatic vegetation. The large amount of dissolved carbonic acid was due principally to this vegetable growth, and so likewise was the very small amount of dissolved oxygen. An ordinary river water during the cooler season of the year has only 0.5 to 2 cubic centimeters of dissolved carbonic acid per liter and 5 to 7 cubic centimeters of oxygen. On adding 2 grains of lime to the gallon, this excess of carbonic acid was thrown down, along with the lime previously existing in solution, in the state of carbonate, and the temporary hardness eliminated. To supply the deficiency of oxygen, I propose that the same plan should be adopted as previous experience had shown to be successful in Brooklyn, Philadelphia, and Hoboken, and that the water should be artificially charged with atmospheric oxygen. The aerated and filtered water was found to have gained its proper percentage of oxygen, to have lost its undue excess of carbonic acid, to be softened, and to have acquired a sweet and pleasant taste.

It sometimes occurs that water has so large an excess of scale forming constituents, that the cost of the required chemicals, even though only soda and lime are employed, is prohibitory. To illustrate, I give below the analysis of two neighboring wells in Florida:

	A.	B.
Free Ammonia	0.007	None
Albuminoid Ammonia	None	0.0105
Required Oxygen	0.09	0.45
Nitrous Acid	None	None
Nitric Acid	0.024	0.033
Sodium Chloride	18.87	136.87
Potasium Chloride	3.91	
Magnesium "	1.06	16.82
Calcium Sulphate	11.52	36.44
" Carbonate	17.10	
Magnesium Carbonate	8.40	16.80
Silica	0.62	3.44
Alumina and Oxide of Iron	0.46	1.80
Dissolved Oxygen per liter	0.86	0.61 c. c.
" Carbonic Acid	4.04	2.20 " "
" Nitrogen	12.14	10.80 " "

The water "A" was softened and rendered suitable for use in boilers, but not for drinking. "B" could not be rendered either soft or portable, its percentage of salt being so great that it curdled soap at once and its hardness could not be estimated by the usual tests.

Very little attention is ordinarily paid to the reaction of water; that is, a to whether they are acid, neutral or alkaline. This is unfortunate, inasmuch as their reaction has an important bearing upon their chemical composition, and upon their fitness for technical use. An absolutely neutral natural water is very rarely met with. Almost always, natural waters are more or less alkaline, a reaction mainly due to dissolved carbonate of lime and carbonate of magnesia. But if estimated in terms of carbonate of lime, the alkalinity ordinarily exceeds the amount of carbonate of lime as found by the empirical soap

test, which is employed in the estimation of the temporary hardness. Usually the alkalinity is not sufficient to be detected by the sense of taste. When the excess of alkaline salts is great enough to affect the taste, it may be neutralized by the addition of a graduated amount of acid, preferably hydrochloric, the resulting sodium chloride and other salts being neutral and harmless. It is a noteworthy fact that this excess of alkali, may coexist in a natural water with a considerable permanent hardness. One of the most striking instances of this anomalous condition is in connection with a sample of water sent from California, which has the following composition:

Free Ammonia	0.0043	grains	per	gallon.
Albuminoid Ammonia	0.0041	"	"	"
Required Oxygen	0.011	"	"	"
Nitrous Acid	0.00011	"	"	"
Nitric Acid	0.0297	"	"	"
Chlorine	1.63	"	"	"
Total Hardness	8.16	"	"	"
Permanent Hardness	7.1	"	"	"
Temporary "	1.06	"	"	"
Alkalinity	11.95	"	"	"
Total Solids	25.90	"	"	"
Mineral Matters	23.4	"	"	"
Organic and Volatile matters	2.5	"	"	"
Dissolved Oxygen per liter	6.73	cubic	centimeters	
" Carbonic Acid	2.44	"	"	
" Nitrogen per liter	14.00	"	"	

High as this alkalinity is, and much as it exceeds both temporary and permanent hardness, it is nevertheless in this instance less than the amount of mineral matters. Waters, however, occur is which, if the alkaline reaction be estimated in terms of carbonate of lime, it is nearly equal to, or greater that the dissolved mineral matters. The water which was originally black, after filtering had a color of 1.4°, or in other words was yellowish-brown. Its composition after filtering, but before softening, was:

Free Ammonia	0.0256	grains	per	gallon.
Albuminoid Ammonia	0.035	"	"	"
Required Oxygen	1.47	"	"	"
Total Hardness	9.68	"	"	"
Alkalinity	12.38	"	"	"
Mineral Matters	14.10	"	"	"
Organic Matters	4.08	"	"	"

On softening this water, the percipitated lime salts carries down with them that portion of the organic matter which gave the dark yellow color, and the water after filtering was both soft and colorless. The oxygen required to oxidize the organic matter which remained in the filtered water after softening, was 1.2 grains per gallon as against 1.47 grains required prior to softening. These results were obtained in my own laboratory by an experimental plant operated by the processes which I have described in the transactions of the New York Academy of Sciences for 1886, and which have since come into general use for the purification of water supplies.

In this Oskaloosa water the alkalinity estimated in terms of carbonate of lime, is 12.38 grains per gallon as against 14.10 grains of mineral matters. In the following instance which is of the water of the Little Lehigh River at Allentown, Pennsylvania, the alkalinity estimated as calcium carbonate, actually exceeds the mineral matters:

Temporary Hardness	1.42	grains	per gallon.
Permanent "	2.15	"	" "
Alkalinity	6.70	"	" "
Mineral Matters	6.53	"	" "
Organic and Volatile matters	1.75	"	" "

On account of this excess, the above water was rejected as unsuitable for employment in a fine technical purpose where a neutral water was required. While the excess could have been cured by artificial means, yet it was deemed wiser to select a water in which this peculiar difficulty had not to be contended with. It is worthy of remark, that even with a strong alkaline reaction, this water contained in solution a minute amount of iron. Now pure water prepared by distillation cannot contain iron and at the same time have an alkaline reaction, and the reason why the natural waters differ in this respect is to be found in their dissolved organic matters which hold up in solution the iron that would otherwise be precipitated by the alkali.

When the water is neutral and has at the same time much dissolved peaty and other vegetable matters (conditions not unusual in soft surface waters) its amount of dissolved iron may be considerable. Still more iron will be found in acid waters, the iron then being in some cases, the most important constituent.

The free acid not only renders the water hard, but enables it to corrode boilers. Such acid hard waters are characteristic of coal mining regions, the acid being derived from oxidation of pyrites. As a typical instance I might mention the composition of a stream entering into the Lackawanna River at Scranton, Pennsylvania. Its taste is strongly acid, and it is yellow and turbid from Iron. It contained (April 21st, 1888):

Free Amonia	0.0081	grains	per gallon
Albuminoid Ammonia	0.0093	"	" "
Required Oxygen	17.51	"	" "
Total Hardness	24.95	"	" "
Permanent "	22.03	"	" "
Temporary "	2.92	"	" "
Total Solids	38.25	"	" "
Mineral Matters	28.68	"	" "

The enormous amount of required oxygen was due to the iron which was held in solution in the condition of protoxide.

By adding alkali to neutral reaction, and driving air into the water, the iron was entirely thrown down in the form of peroxide or rust, and the hardness reduced to 6 or 7 grains per gallon, or eighty-four per cent less than the original amount.

Owing to the very large amount of free acid in this water, the supply was subsequently taken from the Lackawanna itself, in which the acid mainly existed in combination, as follows: (Feb. 1st, 1889.)

Sulphate of Iron	1.3	grains	per gallon
Sulphate of Lime	2.24	"	" "
Sulphate of Magnesia	1.47	"	" "
Sulphate of Soda	0.11	"	" "
Sulphuric Acid	0.03	"	" "
Silica	0.31	"	" "
Sodium Chloride	0.52	"	" "

This analysis shows the change brought about by the acid iron water coming into contact with the carbonate of lime water brought down by the Lackawanna River. This carbonate has been entirely

converted into sulphate, and just as much iron as was previously combined with the acid, has been thrown down in the form of rust on the sides and bottom of the river.

It also shows that even after this change, sulphate of iron, which is very corrosive, and free sulphuric acid still remain. In practice both of these have been neutralized and the dissolved iron removed, before the water has been used for boiler purposes at Scranton.

It remains for me to state what I believe to be the correct principles and methods upon which the removal of the hardening constituents of water should be effected. They are:

First. The operation must be done *in the cold.* The distillation of water is too costly to permit of the use of distilled water except in small quantities. When waste heat can be obtained, the precipitation may be effected by heat and pressure, but the precipitation is usually very incomplete and the scale has to be gotten out of the precipitating tubes or boilers.

Second: The chemicals must operate not only in the cold, but must be very cheap. Lime is the only substance which fulfills these conditions, and it will answer for temporary hardness only. Soda, under proper conditions removes permanent hardness at common temperatures, but as compared with lime it is expensive, and prevents its use when the quantity of water to be softened is large, and its hardness great. Nevertheless, by the use of lime and soda in proper porportions, a water used in a manufacturing establishment, has had its hardness, amounting to forty degrees, and of which three fourths is permanent, reduced to four degrees, that is, made soft.

Third: The removal of the precipitated lime, gypsum, iron, etc., must be effected either by sedimentation or filtration

It can be perfectly effected by sedimentation, the sludge being drawn off by sludge-cocks. The practical difficulty is that sedimentation depends upon quiescence, and the limit is soon obtained when the tanks become too large and costly to permit of their application to considerable amounts of moving water. By thorough contact and admixture of the chemicals with the water, the time required for effecting precipitation can be indefinitely shortened, and the sludge forthwith filtered off. In a subsequent communication, I shall present results obtained by the application of these principles and methods in a number of softening plants erected in this country and in England.

Prof. J. B. Johnson asked whether in the event he should be able to complete his paper on the "Aeration and Sedimentation of Muddy River Water" it could be printed in the proceedings.

It was moved and seconded that the paper should be published. Carried.

The President announced that the next order of business was the selection of the place for the holding of the next meeting of the Association.

The election resulted in the selection of Chicago.

Mr. Gardner as Chairman of the Committee appointed to nominate officers of the Association for the ensuing year, reported the following:

REPORT OF NOMINATING COMMITTEE.

The Committee on Nominations beg leave to recommend the following persons to serve the Association for the ensuing year:

For President.—J. H. Decker. Salina, Kansas.

For Vice-Presidents. W. G. Richards, Atlanta, Ga.; Wm. Ryle, Paterson, N. J.; H. G. Holden. Nashua, N. H.; W. L. Cameron, Memphis, Tenn.; C. N. Priddy, Leadville, Colo.

Secretary and Treasurer. J. M. Diven, Elmira, N. Y.

Finance Committee.—Jas. P. Donahue, Davenport, Ia.; Wm. Molis, Muscatine, Ia.; W. S. Hamilton, Youngstown, Ohio.

For the Committee. L. H. GARDNER, Ch'n.

Mr. Linneen:—I rise to second the report of the Committee and to endorse the nominations made by them. I think, Mr. Chairman, that if there is one member of this Association who deserves well at its hands it is Mr. Decker. He is one of our charter members and has been with us from the beginning; he has labored zealously for the wellfare of this Association and his election as President will be a fitting recognition of his services. The nominations for the other offices I think also reflect great credit on the intelligence and judgment of the committee. I therefore second the motion to adopt the report of the Committee.

The motion to adopt the report of the Committee was carried unamiously, and the Chair appointed Mr. Jones of Kansas City, and Mr. Linneen of Chicago to wait upon the gentlemen elected and inform them of the action of the Association.

The President:—While the Committee are out I will take the opportunity to express to the Association my high appreciation of the courtesy and forbearance you have shown me while I have occupied the Chair of the President. The office, I am glad to say, came to me unsought. I hardly had the right to expect the cordial support and friendship that I have received during the days of our meeting: and I think I cannot conclude better than by wishing our Association con-

tinued success, and that its membership will never be less. (Applause)

Mr. Denman retired from the Chair.

Mr. Darling moved that a vote of thanks of the Association be tendered to our retiring president for the able and efficient and comprehensive manner in which he has performed the duties of his office during the year as President.

Mr. Gardner seconded the motion.

Carried.

The committee returned escorting Mr. Decker.

THE PRESIDENT:—Mr. Decker, by the unamious vote of the Association you have been named as its President for the ensuing year. It is with great pleasure that I surrender into your hands this gavel, and I trust you may find as much pleasure in its use as I have. (Applause.)

MR. DECKER:—Mr. President, and Gentlemen: The honor that has been done me by the Association is so much of a surprise that I must beg you to excuse me if I am unable to properly express my keen appreciation of it now. God knows there is not a member of the Association who has for its interest a warmer place in his heart than I have: I have labored for the success of our Assoctation since its organization in 1881, and while gentlemen, I am free to confess that I have entertained the hope that at some time I might receive the distinction of being President of this body, I had no thought that it would come to me this year or in the near future. I shall enter upon my duties with the happy conviction that I shall receive the hearty co-operation and aid of my fellow members who have thus shown their friendship and indeed partiality towards me.

On motion the Convention then adjourned to meet at Mammoth Cave, Saturday morning.

ADJOURNED MEETING.

MAMMOTH CAVE, KY., Saturday, April 20th, 1889.

Meeting called to order in the "Rotunda" Mammoth Cave at 11:30 a. m. Vice President Diven presiding.

The following applications for membership were read:

ACTIVE

Barrows, F. C., Chairman Water Board.....Minneapolis, Minn
Callahan, A. F., Director Water Co.....Louisville, Ky
Day, L. D., Water Commissioner.....Minneapolis, Minn
Goodnow, W. T., Constructing Engineer.....Nashville, Tenn
Guilford, A. J., Constructing Engineer.....Chicago, Ills
Root, W. J., Mech'l Engineer.....New York, N. Y
Tilden, J. A., Mech'l Engineer.....Boston, Mass

On motion the Secretary cast the ballot of the Association for the above named and they were declared duly elected.

Mr. Donahue offered the following resolution:

Resolved:—That the further thanks of the Association be, and hereby are, tendered Messrs. Dennis Long & Co. for this special trip and for the most royal manner in which we have been cared for.

Mr. Molis offered the following resolution:

Resolved:—That the thanks of the Association are hereby tendered the ladies who have graced this convention by their presence, and added so much to the pleasures of the excursion by their company.

On motion the resolutions was adopted unanimously and then rousing cheers given for the ladies who braved the perils of "Fat Man's Misery" and the "Corkscrew."

On motion the Ninth Annual Convention adjourned *Sine Die*.

J. N. Decker

Secretary.

THE EXHIBITS.

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This feature of the Annual Conventions has not as yet received the attention and cooperation of the associate members which it deserves, and was not nearly so full as should have been.

The following lines however were fairly well represented.

BRASS GOODS, STOP BOXES, ETC.

FIRM AND LOCATION.	REPRESENTATIVE.
Galvin Brass & Iron Works. Detroit Mich..	D. F. O Brien
H. Mueller Mfg. Co.. Decatur, Ill..	H. Mueller
Chapman Valve Mfg. Co.. Indian Orchard. Mass..	E. L. Ross
Ludlow Valve Co.. Troy, N. Y..	R. A. Cairns
Bourbon Copper & Brass Works. Cincinnati. Ohio.	Thos. Fird
J. B. Clow & Co.. Chicago, Ill..	H. S Powell
A. M. Morgan Mfg. Co.. Buffalo. N. Y..	A. M. Morgan
Rouse & Hills Co.. Columbus. Ohio.	Hills

FIRE HYDRANTS AND VALVES.

R. D. Wood & Co., Philadelphia. Pa..	A. T. Prentice
Galvin Brass & Iron Works. Detroit. Mich..	D. F. O'Brien
Chapman Valve Mfg. Co.. Indian Orchard. Mass	E. W. Ross
Ludlow Valve Co. Troy, N. Y.,	R. A. Cairns
Bourbon Copper & Brass Works. Cincinnati. Ohio.	Thos. Fird

METERS.

Hersey Meter Co.. Boston, Mass..	J. A. Tilden
H. R. Worthington. New York. N. Y..	S. A. Welsh
National Meter Co.. New York. N. Y..	J. C. Kelley
Union Water Meter Co.. Worcester, Mass..	J. P. K. Otis
Water Waste Prevention Co.. New York. N. Y..	E. L. Abbott
Frost Meter. Boston Mass..	J. G. Briggs

FILTERS.

Oliphant Filter Co.. New York. N. Y..	Wm. Oliphant
Jewell Pure Water Co., Chicago, Ills..	R. H. Dalzell
Hyatt Pure Water Co.. New York.	Jno. A. Caldwell

OILS

E. H. Kellogg & Co., New York, N. Y., - - - - - - C. H. Hammond

TAPPING MACHINES.

H. Mueller Mfg. Co., Decatur, Ills., - - - - - - - - - H. Mueller
Clarks Tapping Machine, Newark, N. J., - - - - - - Wm. N. Crans

GOVERNORS.

Fisher Governor Co., Marshalltown, Ia., - - - - - - - E. A. Harris

PIPE, ETC.

R. D. Wood & Co., Philadelphia, Pa., - - - - - - - A. T. Prentice
Dennis Long & Co., Louisville, Ky., - - - - - - - - John Long

PUMPING MACHINERY.

Dean Steam Pump Co., Holyoke, Mass., - - - - - - G. W. Dudley
H. R. Worthington, New York N. Y., - - - - - - - - W. J. Root

TECHNICAL PRESS.

Fire and Water, New York, N. Y., - - - - - - - - - F. W. Shepperd
Engineering News, New York N. Y., - - - - - - - - - J. P. Safford
American Engineer, Chicago, Ills., - - - - - - - - - M. Cowles
Western Fireman, Chicago Ills., - - - - - - - - - - - W. Hellis
Engineering & Building Record, New York N. Y., - - F. W. Skinner

ENTERTAINMENT.

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During the Convention the wants and pleasures of those in attendance were most carefully looked after by Messrs. A. F. Callahan of Dennis Long & Co., and P. J. Morritt of the Louisville Water Co.

Wednesday afternoon, through the courtesy of the Louisville Water Co., the Association and its guests were taken by special train to visit the reservoirs, gate house and pumping station of the Water Works.

The party was under the escort of Messrs. Charles R. Long, President, and Chas. Hermany, Chief Engineer of the Louisville Water Co. These gentlemen were untiring in their

efforts to make every one feel at home, and the four hours spent under their leadership were both pleasant and profitable.

THE BANQUET.

The labors of Thursday were most pleasantly closed by a sumptuous banquet spread in the spacious dining room of the Galt. After ample justice had been done the good things solid and liquid, Mr. W. L. Cameron, of Memphis, Tenn., in the capacity of "Toast Master" rapped to order and the following Toasts were offered in their order:

First—"The City of Louisville." This was to have been answered by Mayor Jacob, but he was not present, and the duty fell to Judge Pirtle.

Second—"The New England Water Works Association." Response by Mr. Nevons of Cambridge, Mass.

Third:—"Water." Response by Mr. Richards, of Atlanta.

Fourth:—"The Louisville Water Company." Response by Mr. Charles R. Long.

Fifth—"The Cincinnati Water Works." Response by Col. A. G. Moore, of Cincinnati.

Sixth—"The Local Committee." Response by Mr. Charles Hermany.

Seventh—"Our Absent Friends." Response by Mr. L. H. Gardner, New Orleans.

Eighth—"The Ladies." Response by Mr. J. A. Tilden, of Boston.

These were followed by a number of volunteers and impromptu toasts and when the "wee small hours" came on apace the assemblage retired.

THE EXCURSION TO THE CAVE.

Friday morning at 8:30 in accord with the generous invitation extended by Messrs. Dennis Long & Co., the members of the Association accompanied by a number of invited guests, embarked on special train on the Louisville & Nashville R. R. for Mammoth Cave.

The train consisting of two coaches and buffet car, the latter being well stocked with the luxuries as well as the necessities of life by that prince of caterers Col. Louis Seelbach and presided over by his able Lieutenant Thomas Everson, was well filled by the members of the Association and invited guests.

A ride of a few hours through that grand old state of Kentucky, and a final halt was made at Mammoth Cave just

in time to partake of a substantial dinner at the Hotel. When all had satisfied the inner man, and inner woman as well, the ringing of the old farm bell warned all to "fall in" for the Cave. After considerable delay, occasioned by the ladies vain endeavor to decide what particular costume was best adapted to the trip, a start was finally made. A pleasant walk of a few hundred yards brought the party to the entrance to the cave, where the guides were in waiting with innumerable little lamps. (Just here your humble servant would pause to remark, that as since the Association visited Pike's Peak they have constructed a railway to the summit presumably in deference to the wishes of some who made that memorable trip, he would suggest that the Cave management adopt a system of electric lighting in lieu of these same abominable lamps.)

As for previous arrangement the short route was taken which embraced some eight miles of the mysteries of the depths of the earth, the party returning to the hotel about 7 p. m., with voracious appetites, supper was dispatched the evening was spent in social enjoyment, till an "early to bed" order was issued so as to be able "early to rise" and make the long route Saturday morning after nearly all had breakfasted the "long roll" was rung on the bell and a start was made to finish doing the wonders of the Cave. After a most interesting tramp of some twelve or fourteen miles, taking in the various points of interest such as "Fat man's misery" etc., the party returned through the "Corkscrew" to the "Rotunda," where the adjourned meeting was held. President Denman not having accompanied the party the duty of calling the meeting to order devolved upon Vice President Diven. Mr. Diven thus has acquired the honor of presiding over the lowest and highest meetings held by the Association, he having presided over the special meeting held on the summit of Pike's Peak, Colorado in 1886.

Upon the adjournment the line of march was taken up and after quitting the Cave returned to the Hotel, where after removing the evidences of the tramp, dinner was partaken of, after a short interval the cry resounded "All abroad." The special train was soon filled and a merry time was had until Louisville was reached, about six o'clock p. m.

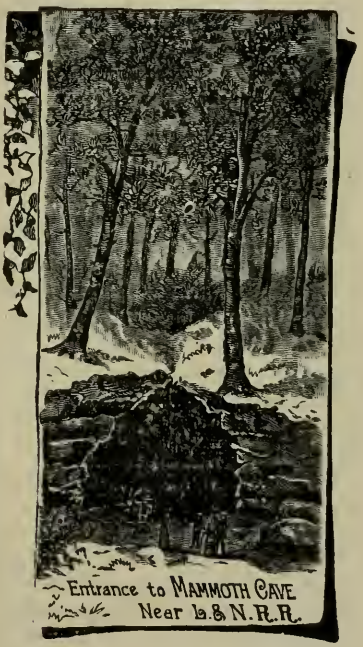
The following is a partial list of the guests in addition to the members and representatives.

Mesdames. J. B. Collins, Louis Seelbach, Chas. Hermany, John Evans, Newton Crawford, Theo. Ahrens Jr., Louisville. W. G. Richards, Atlanta Ga.; S. B. Russell, St. Louis Mo., A. W. Morgan, Buffalo, N. Y.; C. S. Brown, Toledo, Ohio; A.

N. Denman, Des Moines, Ia.; M. F. Thompson, Davenport, Ia.; J. M. Diven and daughter Elmira, N. Y.; Wm. Ryle, Patterson, N. J.

Misses, Irene Hermany, Madaline Hermany, Maggie Johnson, Ella Long, Mary C. Smith, Annie Staub,——Levi, Louisville, Ky.; ———Clendenin, St. Louis, Mo.: M. Ryle, Patterson, N. J.

Messrs. Hiram Nevons, Cambridge, Mass.; J. B. Collins, and son, Louis Seelbach, C. P. Mitchell, N. W. Smith, Thos. Everson, M. W. Barkhouse, D. L. Miller, Chas. F. Bayless, Wm. Sackett. Theo. Ahrens Jr. M. V. Joyes. F. W. Kochler, M. D. Louisville, Ky.; F. W. Stevenson, N. James, Bowling Green, Ky.; J. D. Griffith, Frankfort. Ky.; R. J. Moore, Cincinnati, Ohio; Wm. E. McMillan, J. A. Lemon, New York; Dr. L. H. Mathiz, Chicago, Ills., Henry H. Yates, London, England; W. A. Clendenin, St. Louis, Mo.



IN MEMORIAM.

HARVEY F. GASKELL,

MECHANICAL ENGINEER, LOCKPORT, NEW YORK

DIED APRIL 1, 1889.

HARVEY F. GASKELL was born in Niagara County, New York, January 19th, 1845. He received his early education in the district in which he resided and subsequently graduated from the Poughkeepsie Commercial College. Being of a natural inventive turn of mind he did not adopt any particular profession until 1873; he was however engaged during this time in various classes of manufacture principally in the production of various articles which he had invented and patented. The trend of his mind however being toward machinery and being a close student he directed his study to Mechanical Engineering.

In 1873 he entered the draughting department of the Holly Manufacturing Co., at Lockport, here his true worth and ability were made manifest and promotion was rapid, and at the time of his death he was Vice President and General Superintendent of the Company. His success was remarkable and no monument that can be erected to his memory will be as lasting as that erected by himself in his Pumping Engines.

He became a member of the Association at the Columbus meeting in 1882 and until his death was a most prompt and useful member. In religious belief he was a Presbyterian being for many years a member of the First Presbyterian church of Lockport. He leaves a wife, Mary M., to mourn, but no children, their only child having died in infancy.

In his death, while just entering the prime of life, and only upon the threshold of his career, the Association loses one of its best members, the Water Works fraternity at large, one of its greatest minds, and the manufacturing world one of its most brilliant and skillful inventors.

REQUIESCANT IN PACE.

FINANCIAL STATEMENT.

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1888.					Dr.	Cr.
April 17.	Balance cash on hand				$ 171 55	
	J. S. Walker,	Fees and Dues to 1889.			8 00	
	John F. Lakin.	"	"	"	8 00	
	E. J. Snow.	"	"	"	8 00	
	F. W. Gerecke.	"	"	"	8 00	
	Jas. A. Bond,	"	"	"	8 00	
	S. W. Harris.	"	"	"	8 00	
	W. T. Harris,	"	"	"	8 00	
	John Young,	"	"	"	8 00	
	Thos. J. Neville.	"	"	"	8 00	
	A. R. Wadsworth.	"	"	"	8 00	
	Jno. W. Taylor.	"	"	"	8 00	
	Edward C. Cooke.	"	"	"	8 00	
	Chas. A. Judson.	"	"	"	8 00	
	Philip Morley.	"	"	"	8 00	
	G. H. Benzenberg.	"	"	"	8 00	
	Hall Electric Pump Co.	"	"	"	13 00	
	Rouse and Hills Co.	"	"	"	13 00	
	Wm. Oliphant.	"	"	"	13 00	
	H. De C. Richards.	"	"	"	13 00	
	Jewell Pure Water Co.	"	"	"	13 00	
	Jarvis B. Edson.	"	"	"	13 00	
	John Canlfield.	Dues to 1888.			3 00	
	Chas. P. Allen.	"	"		3 00	
	C. S. Brown.	"	"		3 00	
	Edwin Darling.	"	"		3 00	
	A. N. Denman.	"	"		3 00	
	J. M. Diven.	"	"		3 00	
	J. T. Fanning.	"	"		3 00	
	R. Holme Jr.,	"	"		3 00	
	R. M. Gow.	"	"		3 00	
	J. W. Henion.	"	"		3 00	
	Thos. H. Hooper.	"	"		3 00	
	Wm. Ryle.	"	"		3 00	
	Wm. Fisher,	"	"		3 00	
	B. F. Stephens,	"	"		3 00	
	J. Nelson Tubbs.	"	"		6 00	
	P. J. Neagle.	"	"		3 00	
	J. P. Michellon,	"	"		12 00	
	A. W. Morgan.	"	"		3 00	
	National Meter Co.	"	"		3 00	
	F. A. W. Davis.	"	"		3 00	
	H. E. Keeler.	"	"		3 00	
	J. P. Donahue,	"	"		3 00	
	C. A Hague.	"	"		3 00	

	Chapman Valve Mfg. Co.,	Dues to	1888	3 00
	Galvin Brass & Iron Works,	"	"	3 00
	H. Mueller,	"	"	3 00
	Ludlow Valve Mfg. Co.,	"	"	3 00
	R. D. Wood & Co.,	"	"	3 00
	F. L. Fuller,	"	"	3 00
	Geo. H. Chandler,	"	"	3 00
	S. E. Babcock, (Bal.)	"	"	2 00
	H. W. Ayres,	"	1888	3 00
	F. W. Holly,	"	"	3 00
	P. H. Linneen,	"	"	3 00
	H. F. Gaskell,	"	"	3 00
	H. C. Parrott,	"	"	3 00
	Geo. Hornung,	"	"	3 00
	C. N. Priddy,	"	"	3 00
	J. W. Troy,	"	"	3 00
	B. R. Morton,	"	"	3 00
	R. Beaumont,	"	"	3 00
	E. H. Phipps,	"	"	3 00
	W. G. Richards,	"	"	3 00
	H. R. Worthington,	"	"	3 00
	Columbus Water Works,	"	"	3 00
April 28.	M. L. Holman,	"	1889	3 00
	N. O. Nelson, Mfg. Co.,	"	"	3 00
	Wm. B. Bull,	"	"	3 00
	W. W. Sprague,	"	"	3 00
	J. D. Cook,	"	"	3 00
	The Ohio Pipe Co.,	"	"	3 00
	Harry Birkinbine,	"	"	3 00
April 30.	J. B. Johnston,	"	"	3 00
	Hardwicke and Ware,	"	"	3 00
	Hays Mfg. Co.,	"	"	3 00
	J. D. Houston,	"	"	3 00
	L. H. Gardner,	"	"	3 00
	E. H. Kellogg & Co.,	"	"	3 00
	W. S. Payne,	"	"	3 00
	B. M. Espy,	"	"	3 00
	Davis Cresswell & Co.,	"	"	3 00
	Newark Filtering Co.,	"	"	3 00
	Geo. F. Blake Mfg. Co.,	"	"	3 00
	Chas. B. Brush,	"	"	6 00
	Fred Adee & Co.,	"	"	3 00
	Union Water Meter Co.,	"	"	3 00
	Phinehas Ball,	"	"	3 00
	J. L. Mott, Mfg. Co.,	"	"	3 00
	Rudolph Hering,	"	1889	6 00
	Sam'l M. Elroy,	"	"	6 00
May 1.	I. S. Cassin, On Acc't	"	"	5 00
	Jno. C. Chase,	"	1888	3 00
	H. C. Heermans,	"	"	3 00
May 2.	P. B. Perkins,	"	"	6 00
	E. L. Dunbar,	"	1889	6 00
	Wm. Ludlow,	"	"	6 00
	The Eddy Valve Co.,	"	1888	3 00
May 3.	Desmond Fitzgerald,	"	"	3 00
	August Shaffer,	"	"	3 00
	C. W. Morse,	"	"	6 00

	National Tube Wks Co.,	Dues to	1888	3 00
	W. T. Marsh.	"	"	3 00
	J. F. Sawyer.	"	"	3 00
May 4.	W. S. Kuhn.	"	"	3 00
May 5.	Dennis Long & Co.,	"	"	3 00
	A. F. Kent,	"	"	3 00
	J. J. R. Croes,	"	"	3 00
May 7.	Ripley and Bronson.	"	"	3 00
	E. H. Brown,	"	"	3 00
	J. M. Randall,	"	"	3 00
	Equitable Meter Co.,	"	"	3 00
	A. H. McNeil.	"	"	14 00
May 8.	J. B. Clow & Sons.	"	"	3 00
May 9.	L. J. LeConte.	"	"	3 00
	R. C. B. Bement. Fee and Dues to '89.			8 00
May 11.	M. Joy, Jr., "	"	"	6 00
	Bingham & Taylor.	"	1888	3 00
	H. F. Dunham,	"	"	3 00
	Addyston Pipe & Steel Co.,	"	"	3 00
May 12.	Deane Steam Pump Co.,	"	"	3 00
	E. A. Browere. Fees and Dues to 1889.			8 00
May 14.	Robt. K. Martin.	"	1888.	3 00
	Wm. Bowen,	"	"	3 00
May 19.	Jones & Laughlins,	"	"	3 00
May 21.	Wm. B. Sherman.	Dues to	1888.	3 00
	Philip Buehner.	"	"	3 00
May 23.	Robert Moore.	"	"	3 00
May 26.	Myron Wiltsie.	"	"	6 00
	R. Holme.	"	"	3 00
	W. B. Mills.	"	"	6 00
	James Archer.	"	"	6 00
	Gordon Maxwell Co.,	"	"	3 00
	L. C. Burnes.	"	"	3 00
June 1.	Geo. F. Swain.	"	"	3 00
June 9.	Ezra Clark,	"	1889.	3 00
	Jno. W. Hill.	"	1888.	3 00
June 13.	J. Henry Brown.	"	"	3 00
June 11.	Shickle Harrison & Howard Co.,		"	3 00
	John Martin.	"	"	3 00
June 22.	D. L. Holland.	"	"	3 00
	Reliance Oil & Grease Co., Fees & dues to 1889.			13 00
June 21.	H. H. Harrison.	Dues to	1888.	3 00
	H. G. Holden.	"	"	3 00
	A. H. Howland.	"	"	3 00
	Willis Chipman. Fee and	"	1889.	8 00
July 2.	Wilson Henderson.	"	"	3 00
July 11.	L. A. Taylor.	"	1888.	3 00
July 21.	F. H. Pond.	"	"	3 00
July 27.	R. M. Jones.	"	1889.	3 00
	Gilbert Murdock.	"	"	6 00
	Wm. H. Fritchman. Fee and		1889.	8 00
Aug. 8.	S. Tomlinson,	"	"	3 00
Aug. 27.	Chas. F. Loweth.	"	1888,	3 00
Aug. 28.	H. D. Wood.	"	"	3 00
Sept. 13.	Wm. Mitchell. Fee and	"	1889,	8 00
Sept. 17.	W. H. Searles. On Acc't	"	"	5 00
Sept. 18.	C. F. Manning.	"	1890,	6 00

Oct. 6.	Wm. H. Barney,	Fee and dues to	1889.	8 00
	R. C. P. Coggeshall.	"	"	3 00
Nov. 10.	C. Monjeau.	Fee and "	1890.	8 00
Nov. 23.	Hersey Meter Co.	"	1889.	3 00
Dec. 17.	J. A. Cloud,	"	"	6 00
Dec. 25.	D. Mc. N. Stauffer,	"	"	6 00
1889.				
Jan. 29.	W. K. Harrington.	Fee and "	1890.	8 00
Mar. 21.	J. A. McWilliams.	"	"	3 00
Apr. 3.	Geo. R. Harlow.	"	1889.	9 00
	H. F. Dunham,	Dues to	1889.	3 00
Apr. 13.	Sam'l Tomlinson.	"	1891.	6 00
	Sales Proceedings to date.	"	"	29 05

DISBURSEMENTS.

1888.				
Apr. 17.	Paid	Porterage and charges on Books....	$	1 00
Apr. 18.	"	Papers and Postage.		1 95
Apr. 21.	"	Porterage and charges on Books....		1 50
Apr. 23.	"	Express charges.....		1 10
Apr. 25.	"	Postage, Notice of Dues.....		4 00
Apr. 27.	"	Express charges.....		40
May 4.	"	Postage.....		2 00
May 11.	"	H. F. Dunham Expense Acc't.....		5 00
May 16.	"	Express charges.....		30
June 4.	"	Postage.....		2 00
June 6.	"	"		2 00
June 22.	"	Stenographic Report.....		81 25
July 9.	"	Postage.....		3 00
July 27.	"	Express charges.....		90
Aug. 28.	"	Postage.....		2 00
Aug. 14.	"	Telegram.....		1 10
Aug. 28.	"	Postage.....		2 00
Sept. 1.	"	Letter heads.....		1 25
Oct. 30.	"	Postage Proceedings.....		21 00
Nov. 3.	"	Freight " to Salina.....		10 30
Nov. 10.	"	Postage "		14 00
Nov. 30.	"	Printing "		364 22
Dec. 28.	"	Postage.....		3 00
	"	Express charges.....		1 45
	"	Notice change of office.....		1 25
1889.				
Jan. 11.	"	Postage.....		2 00
Mar. 21.	"	400 R. R. Circulars.....		6 10
Mar. 22.	"	Postage.....		2 00
Mar. 23.	"	Express charges.....		90
Mar. 30.	"	Postage Notices Meeting.....		14 00
Apr. 2.	"	" " "		2 00
Apr. 5.	"	" " "		3 00
	"	Telegram.....		90
Apr. 11.	"	Printing Notices.....		30 72
	"	J. T. Fanning Electrotypes.....		59 93
	"	J. H. Decker, Sec'y Salary.....		300 00
		Balance cash on hand.....		23 08
			$972 60	$972 60

LIST OF MEMBERS.

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HONORARY.

Y. Nakajima, Imperial University ..... Tokio, Japan.

ACTIVE.

Allen, Chas. P., Engineer Waterworks ..... Denver, Col
Andrew, Jas H., Sup't Waterworks ..... Central Falls, R. I.
Archer, James, Water Co ..... Denver Col
Ayres, H. W., C. E. Waterworks ..... Hartford, Conn
Ayres, Sylvanus Jr., Manager Waterworks ..... Bound Brook, N. J
Babcock, S. E., C. E. Waterworks ..... Little Falls, N. Y
Ball, Phinehas, Hydraulic Engineer ..... Worcester, Mass
Barnet, Jno., Sup't Waterworks ..... La Fayette, Ind
Barney, W. H., Sup't Waterworks ..... Milford, Mass
Barrows, F. C., Chairman Water Com ..... Minneapolis Minn
Beach, G. E., Hydraulic Engineer ..... Minneapolis, Minn
Bement, R. C. B., Chief Eng. Duluth Water Co ..... St. Paul, Minn
Benzenburg, G. H., Chief Eng. Water Dep't ..... Milwaukee, Wis
Bergstrom, Andrew, Mech. Eng. Waterw'ks ..... Minneapolis, Minn
Birkinbine, Harry C. E. Waterworks ..... Council Bluffs, Ia
Bixby, Walter A., Superintendent Waterworks ..... Galena, Ill
Bond, Joseph A., Chief Eng. Water Dep't ..... Wilmington, Del
Bowen, Wm., Mec'l Engineer ..... Davenport, Ia
Breckenridge, G. W., President Water Co ..... San Antonio, Tex
Briggs, J. G. Mech'l Engineer ..... Indianapolis, Ind
Brooks, Isaac W., President Water Co ..... Torrington, Conn
Browere, Edward A., M. E. Waterworks ..... Catskill, N. Y
Brown, A. L., M. E. Waterworks ..... Salem, Oregon
Brown, Calvin S., With Hersey Water Co ..... Boston, Mass
Brown, E. H. ..... Grass Valley, Cal
Brown, Geo. W., Superintendent Waterworks ..... Longmont, Col
Brown, J. Henry, Sup't Mystic Div. Water Dep't ..... Boston Mass
Brush, Chas. B., C. E. and Sup't Waterworks ..... Hoboken, N. J
Buehner, Phillip, Waterworks Contractor ..... Portland, Oregon
Bull, Wm. B., Superintendent Waterworks ..... Quincy, Ill
Burns, L. C., Secretary Water Co ..... St. Joseph, Mo
Burnet, Muscoe, Sup't Waterworks ..... Paducah, Ky
Callahan, A. F., Director Water Co ..... Lonisville, Ky
Cameron, W. L., Sec'y and Sup't Waterworks ..... Memphis, Tenn
Campbell, D. F., Sup't Water Co ..... Traverse City, Mich
Carson, J. M., C. E. and Sup't Waterworks ..... Danville, Ill
Case, L. N., Sec'y Waterworks ..... Detroit, Mich
Cassin, Isaac S., Hydraulic Engineer ..... Philadelphia, Pa
Cattell, Alex G., President Water Co ..... Merchantville, N. J
Caulfield, John, Secretary Water Board ..... St Paul, Minn
Chambers, J. N., M. E. Waterworks ..... Birmingham, Ala

Chandler, Geo. H., Engineer Waterworks.....Kalamazoo, Mich
Chase, John C., C. E. and Sup't Waterw'ks.....Wilmington, N. C
Chipman, Willis, Chief Engineer Water Co.....Brockville, Ont
Clark, D. M. Sec'y and Treas. Water Co.....Elyria, Ohio
Clark, Ezra, Pres't and Sup't. Water Commission.....Hartford, Conn
Cloud, J. A., Constructing Engineer.....Jacksonville, Fla
Coggeshall R. C. P., Sup't Waterworks.....New Bedford, Mass
Conant, Whitney, Secretary Water Co.....Long Branch, N. J
Cook, J. D., Consulting Engineer.....Toledo, Ohio
Cook, Edward C., Constructing Engineer.....Tiffin, Ohio
Cole, Jno. A., Civil Engineer.....Hyde Park, Ill
Croes, J. J. R., Consulting Engineer.....New York, N. Y
Darling, Edwin, Superintendent Waterworks.....Pawtucket, R. I
Davis, F. A. W., V. Pres. and Treas. Water.....Indianapolis, Ind
Day, L. D., Civil Engineer.....Minneapolis Minn
Decker, J. H., Sec'y, Treas. and Supt. Water Co.....Salina, Kas
Denman, A. N., Secretary Water Co.....DesMoines, Ia
Diven, J. M., Sec'y and Treas. Water Co.....Elmira, N. Y
Donahue, Jas. P., Vice-President and Supt. Water Co....Davenport, Ia
Doyle, F. P., Sec'y and Sup't Water Co.....Petaluma, Cal
Dunbar, E. L., Sec'y and Sup't Waterworks.....Bay City, Mich
Dunham, H. F. Consulting Engineer.....Cleveland, Ohio
Elliot, Chas., City Superintendent Water Co.....San Francisco, Cal
Ellis, Geo. A., Civil Engineer.....Boston, Mass
Elmer, Howard, Pres't Sayre, Pa., Water Company.....Waverly, N. Y
Elwes, R. Gervase, Civil and Consulting Engineer.....London, Eng
Espy, B. M., Sec'y and Treas. Waterworks.....Wilkesbarre, Pa
Fanning, J. T., Civil and Consulting Eng.....Minneapolis, Minn
Fitzgerald, Desmond, C. E. and Sup't Water Dep't.....Boston, Mass
Foote, C. M., Civil Engineer.....Minneapolis, Minn
Fritchman, W H., Sup't Water Co.....Peoria, Ills
Frost, E. W., Sup't Waterworks.....Colorado Springs, Col
Fry, D. C. Sup't Waterworks.....Jacksonvill, Ills
Fuller, F. L., Constructing Engineer.....Boston Mass
Gaines, A. B., President Water Co.....Hot Springs, Ark
Gardner, L. H., Superintendent Water Co.....New Orleans, La
Gerecke, F. W., Mech'l Engr.....Scranton, Pa
Getchell, W. H., Sec'y Fairbault Water Co.....Minneapolis, Minn
Geyelin, E., Hydraulic Engineer.....Philadelphia, Pa
Goodnow W. T., Constructing Engineer.....Nashville, Tenn
Gow, R. M., Superintendent Waterworks.....Medford, Mass
Gray, L. E., Sup't Waterworks.....Albany, Oregon
Guilford, A. J., Mechanical Engineer.....Chicago Ills
Hague, C. A., Mec. Eng. with H. R. Worthington.....New York, N. Y
Hamilton, W. S. Sup't Waterworks.....Youngstown, Ohio
Hanley, P. M., Superintendent Waterworks.....Fort Madison, Ia
Hanna, J. L., Pres. and Manager Water Co.....Franklin, Pa
Hannah, Jos. E., Eng. and Sup't Waterworks.....Winnipeg, Can
Harlow, Geo. R., Constructing Engineer.....Pittsburg, Pa
Harrington, W. K., Sup't Waterworks.....Green Bay, Wis
Harris, S. W., M. E. Waterworks.....Racine, Wis
Harris, W. T. Sec'y and Treas. Water Co.....Jackson, Tenn
Harrison, H. H., Sup't Waterworks.....Stillwater, Minn
Heermans, H. C., Sup't Waterworks.....Corning, N. Y
Hely, John P., Civil and Hydraulic Engineer.....St. Louis, Mo
Henion, J. W.....Minneapolis, Minn
Henderson, Wilson, Sup't Waterworks.....Peterborough, Ont

Hering, Rudolph ..... New York, N. Y
Hermany. Chas., Chief Engineer Waterworks..... Louisville. Ky
Hill, John W., Mech. Eng..... Cincinnati, Ohio
Hodgkins. H. C. Contracting Engineer..... Syracuse, N. Y
Holden. H. G., Sup't Waterworks..... Nashua N. H
Holland, D. L., M. E..... Saratoga Springs. N.Y
Holly, Frank W., Mechanical Engineer..... Lockport, N. Y
Holman, M. L., Water Commissioner..... St. Louis, Mo
Holme, Richard, Sec'y and Sup't Water Co. ..... Denver. Col
Holme. Richard. Jr., Cashier Water Co..... Denver. Col
Hood. Chas., Superintendent Waterworks..... Burlington. Ia
Hooper. Thomas N., Chief Engineer Waterworks..... Davenport, Ia
Hornung, Geo., Civil Engineer..... Newport, Ky
Howland. A. H., Constructing Engineer..... Boston, Mass
Inman, Geo. B., Contracting Engineer..... New York, N. Y
Jackson. F. M. Sup't Waterworks..... Oak Park, Ills
Johnson, J. B., Prof. Civil Eng. Washington Univ..... St. Louis, Mo
Jones, A. J..... New Brunswick, N.J
Jones, B. F., Sup't Water Co..... Kansas City, Mo
Jones, R. M., Manager Waterworks..... Wyandotte, Kas
Joy. Moses. Jr., President Water Co..... Petersburg, Va
Judson, Chas. A., Sup't Waterworks..... Sandusky, Ohio
Keating, E. H., City Engineer..... Halifax, Nova Scotia
Keeler, H. E., Director Charleston. Ill., Water Co..... Chicago, Ill
Kent, A. F., pres't and Sup't Water Co. ..... Jamestown, N. Y
Koch, H. G., Sup't Waterworks ..... Aspen, Colo
Kuhn, W. S., Contracting Engineer..... McKeesport, Pa
Kuhnen, N., Pres't Water Co..... Davenport, Ia
Laing. W. H., Superintendent Waterworks..... Racine, Wis
Lakin, John T., Sup't Waterworks..... Rockford, Ill
LeConte, L. J., Civil and Consulting Engineer..... Oakland, Cal
Leeds, Albert R., Consulting Chemist..... Hoboken, N. J
Linneen, P. H. Mechanical Engineer..... Chicago, Ills
Loweth, Chas. F., Civil Engineer..... St. Paul, Minn
Ludlow, Wm., C. E..... Philadelphia, Pa
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